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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XII. MIRACLES AND MEDICINE.

By ANDREW DICKSON WHITE, LL. D., L. H. D.,
EX-PRESIDENT OF CORNELL UNIVERSITY.

PART I.

NOTHING in the evolution of human thought appears more inevitable than the idea of supernatural intervention in producing and curing disease. The causes of disease are so intricate that they are reached only after ages of scientific labor. In those periods when man sees everywhere miracle and nowhere law; when he attributes all things which he can not understand to a will like his own, he naturally ascribes his diseases either to the wrath of a good being or to the malice of an evil being.

This idea underlies that connection of the priestly class with the healing of diseases of which we have survivals among rude tribes in all parts of the world, and which is seen in nearly every ancient civilization—especially in the powers over disease claimed in Egypt by the priests of Osiris and Isis, in Greece by the priests of Æsculapius, and in Judea by the priests and prophets of Jahveh.

In Egypt there is evidence reaching back to a very early period that the sick were often regarded as afflicted or possessed by demons; the same belief comes constantly before us in both the great religions of India, in those of China, and it is especially elaborated in Persia. As to the Jews, the Old Testament, so precious in showing the evolution of religious and moral truth among men, attributes such diseases as the leprosy of Miriam and Uzziah, the boils of Job, the dysentery of Jehoram, the withered hand of Jeroboam, the fatal illness of Asa, and many other ills to the wrath of God or the malice of Satan; in the New Testament,

such examples as the woman "bound by Satan," the rebuke of the fever, the casting out of the devil which was dumb, the healing of the person whom "the devil ofttimes casteth into the fire" —of which case one of the greatest modern physicians remarks that never was there a truer description of epilepsy—and various other examples, show this same inevitable mode of thought as a refracting medium through which the teachings and doings of the Great Physician were revealed to future generations.

The civilization of Greece alone appears to have been wholly or nearly free from this idea of the agency of demons in producing bodily ills; hence, Greece was the first of the ancient nations, and indeed the only one, so far as we know, in which a scientific idea of medicine was evolved. Five hundred years before Christ, in the great bloom period of thought, the period of Æschylus, Phidias, Pericles, Soçrates, and Plato, Hippocrates appeared, and his is one of the greatest names in all history. Quietly but thoroughly he broke away from the old tradition, developed scientific thought, and laid the foundations of medical science upon experience, observation, and reason so deeply and broadly that his teaching remains to this hour among the most precious possessions of our race.

His thought was passed on to the School of Alexandria, and there medical science was developed yet further, especially by such men as Herophilus and Erasistratus. Under their lead studies in human anatomy began by dissection; the old prejudice which had weighed so long upon the human race, preventing that method of anatomical investigation without which there can be no real results, was cast aside apparently forever.*

But with the coming in of Christianity a great new chain of events was set in motion which modified most profoundly the further evolution of medical science. The influence of Christi-

* For extended statements regarding medicine in Egypt, Judea, and Eastern nations generally, see Sprengel, Histoire de la Médecine, earlier volumes; and for more succinct accounts, Baas, Geschichte der Medicin, pp. 15–29; also Isensee; also Frédault, Histoire de la Médecine, chap. i. For the effort in Egyptian medicine to deal with demons and witches, see Heinrich Brugsch, Die Aegyptologie, Leipsic, 1891, p. 77; and for references to the Papyrus Ebers, etc., pp. 155, 407, and following. For the derivation of priestly medicine in Egypt, see Baas, p. 22. For the fame of Egyptian medicine at Rome, see Sharpe, History of Egypt, vol. ii, pp. 151 and 184. On the cheapness and commonness of miracles of healing in antiquity, see Sharpe, quoting St. Jerome, vol. ii, pp. 137, 191. As to the freedom of ancient Greece from the idea of demoniacal intervention in disease, see Lecky, History of European Morals, vol. i, p. 404 and note. For the evolution of medicine before and after Hippocrates, see Sprengel, p. 1283 and following. For a good summing up of the work of Hippocrates, see Baas, p. 201. For the necessary passage of medicine in its early stages under priestly control, see Cabanis, The Revolutions of Medical Science, London, 1806, chap. ii. On Jewish ideas regarding demons, and their relation to sickness, see Toy, Judaism and Christianity, Boston, 1891, pp. 168 *et seq.* For Herophilus, Erasistratus, and the School of Alexandria, see Sprengel, vol. i, pp. 433, 434 *et seq.*

anity on the healing art was twofold; there was first a blessed impulse—the thought, aspiration, example, ideals, and spirit of Jesus of Nazareth. This spirit, then poured into the world, flowed down through the ages, promoting self-sacrifice for the sick and wretched. Through all those succeeding centuries, even through the rudest, hospitals and infirmaries sprang up along this blessed stream. Of these were the Eastern establishments for the cure of the sick at the earliest Christian periods; the Infirmary of Monte Casino in the fifth century, the Hôtel-Dieu at Lyons in the sixth, the Hôtel-Dieu at Paris in the seventh, and the myriad refuges for the sick and suffering which sprang up in every part of Europe during the following centuries. Vitalized by this stream, all conceivable growths of mercy bloomed forth. To say nothing of those at an earlier period, we have in the time of the Crusades great charitable organizations like the Order of St. John of Jerusalem, and thenceforward every means of bringing the spirit of Jesus to help afflicted humanity. So, too, through all those ages we have a succession of men and women devoting themselves to works of mercy, culminating during modern times in saints like Vincent de Paul, Francke, Howard, Florence Nightingale, Elizabeth Fry, and Muhlenberg.

But while this vast influence, poured forth from the heart of the founder of Christianity, streamed through century after century, inspiring every development of mercy, there came from those who organized the Church which bears his name, and from those who afterward developed and directed it, another stream of influence—a theology drawn partly from prehistoric conceptions of unseen powers, partly from ideas developed in the earliest historic nations, but especially from the letter of the Hebrew and Christian sacred books.

The theology developed out of our sacred literature in relation to the cure of disease was mainly twofold: first, there was a new and strong evolution of the old idea that physical disease is produced by the wrath of God or the malice of Satan, or by a combination of both, which theology was especially called in to explain; secondly, there were evolved theories of miraculous methods of cure, based upon modes of staying the divine anger, or of thwarting Satanic malice.

Along both these streams of influence, one arising in the life of Jesus, and the other in the reasonings of theologians, legends of miracles grew luxuriantly. It would be utterly unphilosophical to attribute these as a whole to conscious fraud; whatever part priestcraft may have taken afterward in sundry discreditable developments of them, the mass of miraculous legends, century after century, grew up mainly in good faith, and as naturally as elms along water-courses or flowers upon the prairie.

Legends of miracles have thus grown about the lives of all great benefactors of humanity in early ages, and about saints and devotees. Throughout human history the lives of such personages, almost without exception, have been accompanied or followed by a literature in which legends of miraculous powers form a very important part—a part constantly increasing until a different mode of looking at Nature and of weighing testimony causes miracles to disappear. While modern thought holds the testimony to the great mass of such legends in all ages as worthless, it is very widely acknowledged that great and gifted beings who endow the earth with higher religious ideas, gaining the deepest hold upon the hearts and minds of multitudes, may at times exercise such influence upon those about them that the sick in mind or body are helped or healed.

We have within the modern period very many examples which enable us to study the evolution of legendary miracles, and among the most instructive of them all is the life of St. Francis Xavier. One of the noblest characters in the sixteenth century, he sacrificed the brilliant career which he had begun at Paris, and gave himself entirely to missionary work in the far East. Among the various tribes of lower India and afterward in Japan he wrought untiringly, toiling through village after village, collecting the natives by the sound of a hand-bell, trying to teach them the simplest Christian formulas, and thus he brought myriads of them to a nominal confession of the Christian faith. After twelve years of such efforts, seeking new conquests for religion, he sacrificed his life on the desert island of San Chan.

During his career as a missionary he wrote great numbers of letters which were preserved and have since been published; these and the letters of his contemporaries exhibit clearly all the features of his life. His own writings are very minute, and enable us to follow him and his doings fully. No account of a miracle wrought by him appears either in his own letters or in any contemporary document. At the outside but two or three things occurred in his whole life, as exhibited so fully by himself and his contemporaries, for which the most earnest devotee could claim anything like divine interposition; and these are such as may be read in the letters of nearly all fervent missionaries, Protestant as well as Catholic. For example, in the beginning of his career, during a journey in Europe with an ambassador, one of the servants in fording a stream got into deep water and was in danger of drowning. Xavier tells us that the ambassador prayed very earnestly, and that the man finally struggled out of the stream. But within sixty years after his death, at his canonization, and by various biographers, this had been magnified into a miracle, and appears in the various histories dressed out in glowing colors.

Xavier tells us that the ambassador prayed for the safety of the young man, but the biographers tell us that it was Xavier who prayed; and finally, by the later writers Xavier is represented as lifting horse and rider out of the stream by a clearly supernatural act.

Still another claim to miracle is based upon his arrival at Lisbon and finding his great colleague, Simon Rodriguez, ill of fever. Xavier informs us in a very simple way that Rodriguez was so overjoyed to see him that the fever did not return. This is entirely similar to the cure which Martin Luther wrought upon Melanchthon. Melanchthon had broken down and was supposed to be dying, when his joy at the long-delayed visit of Luther brought him to his feet again, after which he lived for many years. Finally, Xavier, finding a poor native woman very ill, baptized her, saying over her the prayers of the Church, and she recovered.

Two or three occurrences like these form the whole basis for the miraculous accounts, so far as Xavier's own writings are concerned.

But shortly after Xavier's death in 1552 miracles of a different sort began to appear. At first they were few and feeble; and two years later Melchior Nunhez, Provincial of the Jesuits in the Portuguese dominions, with all the means at his command, and a correspondence extending throughout all those regions, had been able to hear of but three. These were entirely from hearsay. First, John Deyro said he knew Xavier had the gift of prophecy; but, unfortunately, Xavier himself had reprimanded and cast off Deyro for untruthfulness and cheatery. Secondly, at Cape Comorin many persons affirmed that Xavier had raised a dead person. Thirdly, Father Pablo de Santa Fé said that in Japan Xavier had restored sight to a blind man. This seems a feeble beginning, but little by little the stories grew; and in 1555 De Quadros, Provincial of the Jesuits in Ethiopia, had heard of nine miracles, and laid stress upon the fact that Xavier had healed the sick and cast out devils. The next year, being four years after Xavier's death, King John III of Portugal, a very devout man, in a letter, taking these wonderful works in all parts of the East for granted, directed his viceroy, Barreto, to draw up and transmit to him an authentic account of Xavier's miracles; urging him especially to do the work "with zeal and speedily." We can well imagine what treasures of grace an obsequious viceroy, only too anxious to please a devout king, could bring together by means of the hearsay of ignorant, compliant natives through all the little towns of Portuguese India.

A vast mass of testimony was thus brought together and taken to Rome; but it appears to have been thought of but little value by those best able to judge, for when, in 1588, thirty-six years

after Xavier's death, the Jesuit father Maffei, who had been especially conversant with Xavier's career in the East, published his History of India, though he gave a biography of Xavier which shows fervent admiration for his subject, he dwelt very lightly on the alleged miracles. But six years later, in 1594, Father Tursellinus published his Life of Xavier, and in this appears to have made the first large use of the information collected by the Portuguese viceroy. This work shows a vast increase in the number of miracles over those given by all sources together up to that time. Xavier is represented as not only curing the sick, but casting out devils, stilling the tempest, raising the dead, and performing miracles of every sort.

In 1622 came the canonization proceedings at Rome. Among the speeches made in the presence of Pope Gregory XV, supporting the claims of Xavier to saintship, the most important was by Cardinal Monte. In this the orator selects out ten great miracles from those performed by Xavier during his lifetime and describes them minutely. He insists that on a certain occasion Xavier, by the sign of the cross, made sea-water fresh so that his fellow-passengers and the crew could drink it; that he healed the sick and raised the dead in various places, brought back a lost boat to his ship, was on one occasion lifted from the earth bodily and transfigured before the bystanders; and that, to punish a blaspheming town, he caused an earthquake and buried the offenders in cinders from a volcano: this was afterward still more highly developed, and the saint was represented in engravings as calling down fire from heaven and thus destroying the town.

The most curious miracle of all is the eighth on the cardinal's list. Regarding this he states that Xavier having during one of his voyages lost overboard a crucifix, it was restored to him after he had reached the shore by a crab.

The cardinal also dwelt on miracles performed by Xavier's relics after his death, the most original being that sundry lamps placed before the image of the saint and filled with holy water burned as if filled with oil.

This latter account appears to have deeply impressed the Pope, for in the Bull of Canonization issued by virtue of his power of teaching the universal Church infallibly in faith and morals, his Holiness dwells especially upon the miracle of the lamp filled with holy water and burning before Xavier's image.

Xavier having been made a saint, many other Lives of him appeared, and, as a rule, each surpassed its predecessor in the multitude of miracles. In 1622 appeared that by Father Vitelleschi, and in it not only are the miracles increased, but some old ones are greatly improved. One example will suffice to show the process. In his edition of 1596, Tursellinus had told a story how

Xavier, one day needing money, asked Vellio, one of his friends, to let him have some. Vellio gave him the key of a safe containing thirty thousand gold pieces. Xavier took three hundred and returned the key to Vellio, telling him what he had taken. At this Vellio reproached Xavier for not taking more, saying that he had expected to give him half of all that the strong-box contained. Xavier, touched by this generosity, told Vellio that the time of his death should be made known to him, that he might have time to repent of any sins and prepare for eternity. But twenty-six years later, Vitelleschi, in his Life of Xavier, telling the story, says that Vellio on opening the safe found that all his money remained as he had left it, and that none at all had disappeared; in fact, that there had been a miraculous restoration. On his blaming Xavier for not taking the money, Xavier declares to Vellio that not only should he be apprised of the moment of his death, but that he should always have all the money he needed. Still later biographers improved the account further, declaring that Xavier promised Vellio that the strong-box should always contain money sufficient for his needs.

In 1682, one hundred and thirty years after Xavier's death, appeared his biography by Father Bouhours; and this became a classic. In it miracles of all kinds were enormously multiplied, and many new ones given. Miracles few and small in Tursellinus are many and great in Bouhours, and among the new ones is a miraculous draught of fishes. It must be remembered that Bouhours, writing ninety years after Tursellinus, could hardly have had access to any really new sources; Xavier had been dead one hundred and thirty years, and of course all the natives upon whom he had wrought his miracles, and their children and grandchildren, were gone. It can not then be claimed that Bouhours had the advantage of any new witnesses, nor could he have had anything new in the way of contemporary writings; for, as we have seen, the missionaries of Xavier's time wrote nothing regarding his miracles, and certainly the ignorant natives of India and Japan did not commit any account of his miracles to writing. Nevertheless, the miracles of healing given in Bouhours were more numerous and brilliant than ever. But there was far more than this. Although during the lifetime of Xavier there is, neither in his own writings nor in any contemporary account the least indication of resurrections from the dead, we find that shortly after his death stories of resurrections wrought by him during his lifetime began to appear. A simple statement of the growth of these may throw some light on the evolution of miraculous accounts generally. At first it was affirmed that some people at Cape Comorin said that he resuscitated one person; then it was said that there were two persons; then in various authors,

Acosta, De Quadros, and others, the story wavers between one and two cases; finally, in the time of Tursellinus, four cases had been developed. In 1622, at the canonization proceedings, three were mentioned; but, by the time of Father Bouhours, there were twenty-five.

It seems to have been felt as somewhat strange at first that Xavier had never alluded to any of these wonderful miracles; but ere long a subsidiary legend was developed, to the effect that one of the brethren asked him one day if he had raised the dead, whereat he blushed deeply and cried out against the idea, saying: "And so I am said to have raised the dead! What a misleading man I am! Some men brought a youth to me just as if he were dead, who, when I commanded him to arise in the name of Christ, straightway arose."

Noteworthy is the evolution of other miracles: Tursellinus, writing in 1594, tells us that on the voyage from Goa to Malacca, Xavier having left the ship and gone upon an island, was afterward found by the persons sent in search of him so deeply absorbed in prayer as to be unmindful of all things about him. But in the next century Father Bouhours develops the story as follows: "The servants found the man of God raised from the ground into the air, his eyes fixed upon heaven, and rays of light about his countenance."

Instructive, also, is a comparison between the accounts of his great miracle among the Badages at Travancore in 1544. In Xavier's letters he makes no reference to anything extraordinary; but Acosta, in 1573, declares that "Xavier threw himself into the midst of the Christians, that reverencing him they might spare the rest." The inevitable evolution of this matter goes on; and after twenty years Tursellinus tells us that at the onslaught of the Badages, "they could not endure the majesty of his countenance and the splendor and rays which issued from his eyes, and out of reverence for him they spared the others." The process of incubation still goes on during ninety years more, and then we have Bouhours's account: having given Xavier's prayer on the battle-field, Bouhours goes on to say that the saint, crucifix in hand, rushed at the head of the people toward the plain where the enemy was marching, and "said to them in a threatening voice, 'I forbid you in the name of the living God to advance further, and on his part command you to return in the way you came.' These few words cast a terror into the minds of those soldiers who were at the head of the army; they remained confounded and without motion. They who marched afterward, seeing that the foremost did not advance, asked the reason of it; the answer was returned from the front ranks that they had before their eyes an unknown person habited in black, of more than

human stature, of terrible aspect, and darting fire from his eyes. . . . They were seized with amazement at the sight, and all of them fled in precipitate confusion."

Curious, too, is the after-growth of the miracle of the crab restoring the crucifix. In its first form Xavier lost the crucifix in the sea, and the earlier biographers dwell on the sorrow which he showed in consequence; but the later historians declare that the saint threw the crucifix into the sea in order to still a tempest. In this form we find it among illustrations of books of devotion in the next century.

But perhaps the best illustration of this evolution of miracles in Xavier's case is to be found in the growth of another legend; and it is especially instructive because it grew luxuriantly despite the fact that it was utterly contradicted in all parts of Xavier's writings.

Throughout his letters, from first to last, Xavier constantly dwells upon his difficulties with the various languages of the different tribes among whom he went. He tells us how he surmounted these difficulties: sometimes by learning just enough of a language to translate into it some of the main Church formulas; sometimes by getting the help of others to patch together some pious teachings to be learned by rote; sometimes by employing interpreters; and sometimes by a mixture of various dialects and by signs. On one occasion he tells us that a very serious difficulty arose, and that his voyage to China was delayed because, among other things, the interpreter he had engaged had failed to meet him.

In various Lives which appeared between the time of his death and his canonization, this difficulty is much dwelt upon; but during the canonization proceedings at Rome, in the great speeches then made, and finally in the papal bull, great stress was laid upon the fact that Xavier possessed the gift of tongues. It was declared that he spoke to the various tribes with ease in their own languages. This legend of Xavier's miraculous gift of tongues was especially mentioned in the papal bull, and was solemnly given forth by the pontiff as an infallible statement to be believed by the universal Church. Gregory XV having been prevented by death from issuing the Bull of Canonization, it was finally issued by Urban VIII. To a thinking man there is much food for reflection in the fact that the same pope who punished Galileo, and was determined that the Inquisition should not allow the world to believe that the earth revolves about the sun, thus solemnly ordered the world, under pain of damnation, to believe in Xavier's miracles, including his "gift of tongues," and the return of the crucifix by the pious crab. But the legend was developed still further: Father Bouhours tells us, "The holy

man spoke very well the language of those barbarians without having learned it, and had no need of an interpreter when he instructed." And, finally, in our own time, the Rev. Father Coleridge, speaking of the saint among the natives, says, "He could speak the language excellently, though he had never learned it."

In the early biography, Tursellinus writes: "Nothing was a greater impediment to him than his ignorance of the Japanese tongues; for, ever and anon, when some uncouth expression offended their fastidious and delicate ears, the awkward speech of Francis was a cause of laughter." But Father Bouhours, a century later, writing of Xavier at the same period, says, "He preached in the afternoon to the Japanese in their language, but so naturally and with so much ease that he could not be taken for a foreigner."

And finally, in 1872, Father Coleridge, of the Society of Jesus, speaking of Xavier at this time, says, "He spoke freely, flowingly, elegantly, as if he had lived in Japan all his life."

Nor was even this sufficient: to make the legend complete, it was declared that, when Xavier addressed the natives of various tribes, each heard the sermon in his own language in which he was born.*

It is hardly necessary to attribute to the orators and biographers generally a conscious attempt to deceive. The simple fact is, that as a rule they thought, spoke, and wrote in obedience to the natural laws which govern the luxuriant growth of myth and legend in the warm atmosphere of love and devotion which constantly arises about great religious leaders in times when men have little or no knowledge of natural law, when there is little care for scientific evidence, and when he who believes most is thought most meritorious.

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* For the evolution of the miracles of Xavier, see his Letters with Life, published by Léon Pagès, Paris, 1855. Also, Maffei, Historiarum Indicarum, Libri xvi, Venice, 1589. Also the Lives by Tursellinus, various editions, beginning with that of 1596; Vitelleschi, 1622; Bouhours, 1682; Massei, second edition, 1682 (Rome), and others; Fabers Bartoli, Baltimore, 1868; Coleridge, 1872. In addition to these, I have compared, for a more extended discussion of this subject hereafter, a very great number of editions of these and other biographies of the saint with speeches at the canonization, the Bull of Gregory XIII, various books of devotion, and a multitude of special writings, some of them in manuscript, upon the glories of the saint. The illustration of the miracle of the crucifix and crab in its final form is given in La Dévotion de Dix Vendredis à l'Honneur de St. François Xavier, Bruxelles, 1699, Fig. 24. For the letter of King John to Barreto see Léon Pagès's Lettres de St. François Xavier, Paris, 1855, vol. ii, p. 465. For the miracle among the Badages, compare Tursellin. lib. ii, c. x, p. 16, with Bouhours, Dryden's translation, pp. 146, 147. For miracle of the gift of tongues, in its higher development, see Bouhours, p. 143, and Coleridge, vol. i, pp. 172 and 208; and as to Xavier's own account see Coleridge, vol. i, pp. 151, 154, and vol. ii, 551.

These examples will serve to illustrate the process which in thousands of cases has gone on from the earliest days of the Church until a very recent period. Everywhere miraculous cures became the rule rather than the exception throughout Christendom.

So it was that, throughout antiquity, during the early history of the Church, throughout the middle ages, and indeed down to a comparatively recent period, testimony to miraculous interpositions which would now be laughed at by a school-boy was accepted by the leaders of thought. St. Augustine was certainly one of the strongest minds in the early Church, and yet we find him mentioning, with much seriousness, a story that sundry innkeepers of his time put a drug into cheese which metamorphosed travelers into domestic animals. With such a disposition regarding the wildest stories, it is not surprising that the assertion of St. Gregory of Nazianzen, during the second century, as to the cures wrought by the martyrs Cosmo and Damian, was echoed from all parts of Europe until every hamlet had its miracle-working saint or relic.

The literature regarding these miracles is simply endless. To take our own ancestors alone, no one can read the Ecclesiastical History of Bede, or Abbot Samson's Miracles of St. Edmund, or the accounts given by Eadmer and Osberne of the miracles of St. Dunstan, or the long lists of those wrought by Thomas à Becket, or by any other in the army of English saints, without seeing the perfect naturalness of this growth. This evolution of miracle in all parts of Europe came out of a vast preceding series of beliefs, extending not merely through the early Church, but far back into paganism. Just as formerly people were cured in the temples of Æsculapius, so now they were cured at the shrines of saints. Moreover, the miracles of the sacred books were taken as models, and each of those given by the sacred chroniclers was repeated during the early ages of the Church and through the mediæval period with endless variations of circumstance, but still with curious fidelity to the original type.

It should be especially kept in mind that, while the vast majority of these were doubtless due to the myth-making faculty and to that development of legends which always goes on in ages ignorant of the relation between physical causes and effects, some of the miracles of healing may have had some basis in fact. We, in modern times, have seen too many cures performed through influences exercised upon the imagination, such as those of the Jansenists at the Cemetery of St. Médard, of the Ultramontanes at La Salette and Lourdes, and of various Protestant sects at Old Orchard and elsewhere, as well as at sundry camp-meetings, to doubt that some cures, more or less permanent, were wrought by

sainted personages in the early Church and throughout the middle ages.*

But miraculous cures were not ascribed to persons merely. Another growth, mainly from germs in our sacred books developed by the early Church, took shape in miracles wrought by streams, by pools of water, and especially by relics. Here, too, the old types persisted, and just as we find holy and healing wells, pools, and streams in all other ancient religions, so we find in the evolution of our own such examples as Naaman the Syrian cured of leprosy by bathing in the river Jordan, the blind man restored to sight by washing in the pool of Siloam, and the healing of those who touched the bones of Elisha, the shadow of St. Peter, or the handkerchief of St. Paul.

St. Cyril, St. Ambrose, St. Augustine, and other great fathers of the early Church sanctioned the belief that similar efficacy was to be found in the relics of the saints of their time; hence, St. Ambrose declared that "the precepts of medicine are contrary to celestial science, watching, and prayer"; and we find this statement reiterated from time to time throughout the middle ages. From this idea was evolved that fetichism which we shall see for ages standing in the way of medical science.

Theology, developed in accordance with this idea, wrapped all scientific effort more and more in an atmosphere of supernaturalism. The vividness with which the accounts of miracles in the sacred books were realized in the early Church continued the idea of miraculous intervention throughout the middle ages. The

* For the story of travelers converted into domestic animals, see St. Augustine, De Civ. Dei, liber xviii, chaps. xvii, xviii, in Migne, tom. xli, p. 574. For Gregory of Nazianzen and the similarity of these Christian cures in general character to those wrought in the temples of Æsculapius, see Sprengel, vol. ii, pp. 145, 146. For the miracles wrought at the shrine of St. Edmund, see Samsonis Abbatis Opus de Miraculis Sancti Ædmundi, in the Master of the Rolls series, *passim*, but especially chaps. xiv and xix, for miracles of healing wrought on those who drank out of the saint's cup. For the mighty works of St. Dunstan, see the Mirac. Sanct Dunstan, Auctore Eadmero and Auctore Osberno, in the Master of the Rolls series. As to Becket, see the materials for the Life of Thomas à Becket in the same series, and especially the lists of miracles—the mere index of them in the first volume requires thirteen octavo pages. For St. Martin of Tours, see the Guizot edition of French Chronicles. For miracle and shrine cures chronicled by Bede, see his Ecclesiastical History, *passim*, but especially from page 110 to page 267. For similarity between the ancient custom of allowing invalids to sleep in the temples of Serapis and the mediæval custom of having them sleep in the church of St. Antony of Padua and other churches, see Meyer, Aberglaube des Mittelalters, Basel, 1884, chap. iv. For the effect of "the vivid belief in supernatural action which attaches itself to the tombs of the saints," etc., as "a psychic agent of great value," see Littré, Médecine et Médecins, p. 131. For the Jansenist miracles at Paris, see La Vérité des Miracles opérés par l'Intercession de M. de Paris, par Montgéron, Utrecht, 1737, and especially the cases of Mary Anne Couronneau, Philippe Sergent, and Gautier de Pezenas. For some very thoughtful remarks as to the worthlessness of the testimony to miracles presented during the canonization proceedings at Rome, see Maury, Légendes Pieuses.

testimony of the great fathers of the Church to the continuance of miracles is overwhelming; but everything shows that they so fully expected miracles on the slightest occasion as to require nothing which in these days would be regarded as adequate evidence.

In this atmosphere of theologic thought, medical science was at once checked. The School of Alexandria, under the influence first of Jews and later on of Christians, both permeated with Oriental ideas, and taking into their theory of medicine demons and miracles, soon enveloped everything in mysticism. In the Byzantine Empire of the East the same cause produced the same effect: the evolution of ascertained truth in medicine begun by Hippocrates and continued by Herophilus, seemed lost forever. Medical science, trying to move forward, was like a ship becalmed in the Sargasso Sea: both the atmosphere about it and the medium through which its progress must be made resisted all movement. Instead of reliance upon observation, experience, experiment, and thought, attention was turned toward supernatural agencies.*

Especially prejudicial to a true development of medical science among the first Christians was their attribution of disease to diabolic possession. St. Paul had distinctly declared that the gods of the heathen were devils; and everywhere the early Christians saw in disease the malignant work of these dethroned powers of evil. The Gnostic and Manichæan struggles had ripened the theologic idea that at times diseases are punishments by the Almighty, but that the main agency in them is Satanic. The great fathers and renowned leaders of the early Church accepted and strengthened this idea. Origen says: "It is demons which produce famine, unfruitfulness, corruptions of the air, pestilences; they hover concealed in clouds in the lower atmosphere and are attracted by the blood and incense which the heathen offer to them as gods." St. Augustine says: "All diseases of Christians are to be ascribed to these demons; chiefly do they torment fresh-baptized Christians, yea, even the guiltless, new-born infants." Tertullian insists that a malevolent angel is in constant attendance upon every person. Gregory of Nazianzen declares that bodily pains are provoked by demons, and that medicines are useless, but that they are often cured by the laying on of consecrated hands. St. Nilus and St. Gregory of Tours, echoing St. Ambrose, give examples to show the sinfulness of resorting to medicine instead of trusting to the intercession of saints. Leaders of the Church very gener-

* For the mysticism which gradually enveloped the School of Alexandria, see Barthélemy Saint-Hilaire, De l'École d'Alexandrie, Paris, 1845, vol. vi, p. 161. For the effect of the new doctrines on the Empire of the East, see Sprengel, vol. ii, p. 240. As to the more common miracles of healing and the acknowledgment of non-Christian miracles of healing by Christian fathers, see Fort, p. 84.

ally scouted the theory that diseases are due to natural causes, and most of them deprecated a resort to surgeons and physicians rather than to supernatural means.*

Other considerations were developed as the middle ages went on which strengthened this idea. Again we must bear in mind that while there is no need to attribute the mass of these stories regarding miraculous cures to conscious fraud, there was, without doubt, at a later period, no small admixture of belief biased by self-interest, with much pious invention and suppression of facts. Enormous revenues flowed into various monasteries and churches in all parts of Europe from relics noted for their healing powers. Every cathedral, every great abbey, and nearly every parish church claimed possession of healing relics. While, undoubtedly, a childlike faith was at the bottom of this belief, there came out of it unquestionably a great development of the mercantile spirit. The commercial value of sundry relics was often very high. In the year 1056 a French ruler pledged securities to the amount of ten thousand solidi for the production of the relics of St. Just and St. Pastor, pending a legal decision regarding the ownership between him and the Archbishop of Narbonne. The Emperor of Germany on one occasion demanded, as a sufficient pledge for the establishment of a city market, the arm of St. George. The body of St. Sebastian brought enormous wealth to the Abbey of Soissons; Rome, Canterbury, Treves, Marburg, every great city drew large revenues from similar sources, and the Venetian Republic ventured very considerable sums in the purchase of relics.

Naturally, then, the corporations, whether lay or ecclesiastical, which drew large revenue from relics looked with little favor on a science which tended to discredit their investments.

Nowhere perhaps in Europe can the philosophy of this development of fetichism be better studied than at Cologne. At the cathedral, preserved in a magnificent shrine since about the twelfth century, are the skulls of the Three Kings or Wise Men of the East, who, guided by the star of Bethlehem, brought incense to the Saviour. These relics were an enormous source of wealth to the cathedral chapter during many centuries. But other ecclesiastical bodies in that city were both pious and shrewd, and so we find that not far off, at the church of St. Gereon, a cemetery has been dug up, and the bones distributed over the

* For Origen, see the Contra Celsum, lib. vii, chap. 31. For Augustine, De Divinit. et Demon., chap. iii, p. 371. For Tertullian and Gregory of Nazianzen, see citations in Sprengel and in Fort, p. 6. For Gregory of Tours and St. Nilus, see History of France, vol. v, p. 6; De Mirac. S. Martini, vol. ii, p. 60; cited in the History of the Iniquisition of the Middle Ages, by Henry Charles Lea, New York, 1888, p. 410, note. For the turning of the Greek mythology into a demonology as largely due to St. Paul, see I Corithians, chap. x, v. 20: "The things which the Gentiles sacrifice, they sacrifice to devils and not to God."

walls as the relics of St. Gereon and his Theban band of martyrs! Again, at the neighboring church of St. Ursula, we have the later spoils of another cemetery, covering the interior walls of the church as the bones of St. Ursula and her eleven thousand virgin martyrs: the fact that anatomists now declare many of them to be the bones of men does not appear in the middle ages to have diminished their power of competing with the relics at the other shrines in healing efficiency.

Other developments of fetich cure were no less discouraging to the evolution of medical science. Very important among these was the Agnus Dei, or piece of wax from the Paschal candles stamped with the figure of a lamb, and consecrated by the pope. As late as 1471 Pope Paul II expatiated to the Church on the efficacy of this fetich in preserving men from fire, shipwreck, tempest, lightning, and hail, and in assisting women in childbirth; and he reserved to himself and his successors the manufacture of it.

Naturally the frame of mind thus stimulated created a necessity for amulets and charms of other kinds; and under this influence we find a reversion to old pagan fetiches: nothing on the whole stood more constantly in the way of any proper development of medical science than these fetich cures, whose efficacy was based on theological modes of reasoning.

It would be expecting too much from human nature to imagine that pontiffs who derived large revenues from the sale of the Agnus Dei, or that priests who derived both wealth and honors from cures wrought at shrines under their care, or that lay dignitaries who had invested heavily in relics should favor the development of any science which undermined their interests.* Moreover, other developments of thought in the Church were hardly less fatal to the evolution of medical science.

First of these was a wide-spread Egyptian and Oriental theory, mainly transmitted through the Jewish sacred books, of the unlawfulness of meddling with the bodies of the dead. And when to this was added the mysterious idea of the human body as the temple of the Holy Ghost, and a dread of interfering with it lest some injury might result in its final resurrection at the day of judgment, there came an addition to the mysterious reasons which forbade men to pursue the study of anatomy by means of dissection. Tertullian denounced the anatomist Herophilus as a butcher; Augustine spoke of anatomists generally in similar terms. The threat of excommunication launched by Pope Boni-

* See Fort's Medical Economy during the Middle Ages, pages 211–213; also the Handbooks of Murray and Baedeker for North Germany, and various histories of medicine *passim*; also Collin de Plancy and scores of others. For an account of the Agnus Dei, see Rydberg, pp. 62, 63.

face VIII against those guilty of dissections was simply a development of this feeling.

Still further, in spite of the fearful cruelties which the Church, when firmly established, promoted so freely against those suspected of witchcraft or heresy, there grew up a theory which took shape in the maxim that "the Church abhors the shedding of blood," and this maxim was used with deadly effect against the progress of surgery. It led to ecclesiastical mandates which withdrew from this branch of the healing art the most thoughtful and cultivated men of the middle ages, and which placed surgery in the hands of the lowest class of nomadic charlatans. So deeply was this idea thus rooted in the universal Church that for over a thousand years surgical practice was considered dishonorable; the greatest monarchs were often unable to secure an ordinary surgical operation; and it was only in 1406 that a better beginning was made, when the Emperor Wenzel of Germany ordered that dishonor should no longer attach to the surgical profession.*

In spite of all these opposing forces, the evolution of medical science continued, though but slowly. In the second century of the Christian era Galen had made himself a great authority at Rome, and from Rome had swayed the medical science of the world: his genius triumphed over the defects of his method; but, though he gave a powerful impulse to medicine, his dogmatism stood in the way of it long afterward.

The places where medicine, such as it thus became, could be applied, were at first mainly the infirmaries of various monasteries, especially the larger ones of the Benedictine Order. These were frequently developed into hospitals: many monks devoted themselves to such medical studies as were permitted, and sundry churchmen and laymen did much to secure and preserve copies of ancient medical treatises. So, too, in the cathedral schools established by Charlemagne and others, provision was generally made for medical teaching; but all this instruction, whether in convents or schools, was wretchedly poor. It consisted not in the development by individual thought and experiment of the gifts of Hippocrates, Aristotle, and Galen, but almost entirely in the parrot-like repetition of their writings.

But while the inherited ideas of church leaders were thus unfavorable to any proper development of medical science, there were two bodies of men outside the Church who, though largely fettered by superstition, were far less so than the monks and students of ecclesiastical schools: these were the Jews and the Mohammedans. The first of these especially had inherited many

* As to denunciations of surgery by the Church authorities, see Sprengel, II, 7, 8; also, Fort, pp. 452 *et seq.*; and for the reasoning which led the Church to forbid surgery to priests, see especially Frédault, Histoire de la Médecine, p. 200.

useful sanitary and hygienic ideas, which had probably been first evolved by the Egyptians, and from them transmitted to the world mainly through the sacred books attributed to Moses; and both Jews and Mohammedans, while fettered by various superstitions of their own, were far less influenced by the mediæval development of miracles than were their Christian contemporaries.

The Jewish scholars became especially devoted to medical science. To them is largely due the creation of the School of Salerno, which we find flourishing in the tenth century. Judged by our present standards, its work was poor indeed, but, compared with other medical instruction of the time, it was vastly superior: it developed hygienic principles especially, and brought medicine upon a higher plane.

Still more important is the rise of the School of Montpellier; this was due almost entirely to Jewish physicians, and it developed medical studies to a yet higher point, doing much to create a medical profession worthy of the name throughout southern Europe.

As to the Arabians, we find them from the tenth to the fourteenth century, especially in Spain, giving much thought to medicine, and to chemistry as subsidiary to it. About the beginning of the ninth century, when the greater Christian writers were supporting fetich by theology, Almamon, the Moslem, declared, "They are the elect of God, his best and most useful servants, whose lives are devoted to the improvement of their rational faculties." The influence of Avicenna, the translator of the works of Aristotle, from the beginning of the eleventh century extended throughout all Europe. The Arabians were indeed much fettered by tradition in medical science, but their translations of Hippocrates and Galen preserved to the world the best thus far developed in medicine, and still better were their contributions to pharmacy; these remain of value to the present hour.*

Various Christian laymen also rose above the prevailing theologic atmosphere far enough to see the importance of promoting scientific development. First among these we may name the Emperor Charlemagne; he and his great minister, Alcuin, not only promoted medical studies in the schools they founded, but also made provision for the establishment of botanic gardens in which

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* For the great services rendered to the development of medicine by the Jews, see Monteil, Médecine en France, p. 58; also the historians of medicine generally. For the quotation from Almamon, see Gibbon, vol. x, p. 42. For the services of both Jews and Arabians, see Bédarride, Histoire des Juifs, p. 115. Also Sismondi, Histoire des Français, cited by Fort, pp. 449, 450. For Arabians, especially, see Rosseuw Saint-Hilaire, Histoire d'Espagne, Paris, 1844, vol. iii, pp. 191 *et seq.* For the tendency of the Mosaic books to insist on hygienic rather than therapeutical treatment, and its consequences among Jewish physicians, see Sprengel, but especially Frédault, p. 14.

those herbs were especially cultivated which were supposed to have healing virtues. So, too, in the thirteenth century, the Emperor Frederick II, though under the ban of the pope, brought together in his various journeys, and especially in his crusading expeditions, many Greek and Arabic manuscripts, and took special pains to have those which concerned medicine preserved and studied; he also promoted better ideas of medicine, and embodied them in law.

Men of science also rose, in the stricter sense of the word, even in the centuries under the most complete sway of theological thought and ecclesiastical power; a science, indeed, alloyed with theology, but still infolding precious germs. Of these were men like Arnold of Villanova, Bertrand de Gordon, Albert of Bollstadt, Basil Valentine, Raymond Lull, and, above all, Roger Bacon, all of whom cultivated sciences subsidiary to medicine, and in spite of charges of sorcery, and consequent imprisonment and danger of death, kept the torch of knowledge burning, and passed it on to future generations.*

From the Church itself, also, even when the theological atmosphere was most dense, rose here and there men who persisted in something like scientific effort. As early as the ninth century, Bertrarius, a monk of Monte Casino, prepared two manuscript volumes of prescriptions selected from ancient writers; other monks studied them somewhat, and during succeeding ages, scholars like Hugo, Abbot of St. Denis; Sigoal, Abbot of Epinay; Hildegarde, Abbess of Rupertsberg; Milon, Archbishop of Beneventum; John of St. Amand, Canon of Tournay, did something for medicine as they understood it. Unfortunately, they generally understood its theory as a mixture of deductions from Scripture with dogmas from Galen, and its practice as a mixture of incantations with fetiches. Even Pope Honorius III did something for the establishment of medical schools; but he did so much more to place ecclesiastical and theological fetters upon teachers and taught, that the value of his gifts may well be doubted. All germs of a higher evolution of medicine were for ages well kept under by the theological spirit. As far back as the sixth century so great a man as Pope Gregory I showed himself hostile to every development of science. In the beginning of the twelfth century the Council of Rheims interdicted the study of law and physic to monks, and a multitude of other councils enforced this decree. About the middle of the same century

* For the progress of sciences subsidiary to medicine even in the darkest ages, see Fort. pp. 374, 375. Also, Isensee, Geschichte der Medicin, pp. 225 *et seq.* Also, Monteil, p. 89, Heller, Geschichte der Physik, vol. i Buch II. Also Kopp, Geschichte der Chemie. For Frederick II and his Medicinal Gesetz, see Baas, p. 221, but especially Von Raumer, Geschichte der Hohenstaufen, Leipsic, 1872, vol. iii, p. 259.

St. Bernard still complained that monks had too much to do with medicine; and a few years later we have decretals like those of Pope Alexander III forbidding monks to study or practice it. In the beginning of the next century Innocent III, in the Council of the Lateran, forbade surgical operations to be practiced by priests, deacons, and sub-deacons; some years later Honorius III reiterated this decree and extended it. In 1243 the Dominican Order forbade medical treatises to be brought into their monasteries. Five years later the Council of Le Mans forbade surgery to monks, on the ground that "the Church abhors the shedding of blood," and many other councils did the same. At the end of that century Boniface VIII interdicted dissections as sacrilege.*

ICE-MAKING AND MACHINE REFRIGERATION.

By FREDERIK A. FERNALD.

THE manufacture of ice now bids fair to become a regular industry in temperate as well as in tropical climates. Pioneer work in this field was done more than sixty years ago, but it is only within the last ten years that the groping attempts of the early inventors have developed into processes sufficiently economical to make the artificial production of ice a commercial success. Artificial ice has been made in tropical countries and in our Southern cities for many years, but the industry has been greatly extended in this country by the two successive mild winters of 1888–'89 and 1889–'90. It has now gained a foothold even in our Northern States, while in the South comparatively small towns have their ice factories.

The scientific fact on which the making of artificial ice depends is that when a liquid evaporates it uses up a great deal of heat, which it draws from anything that happens to be around it. If a can of water is at hand, its temperature is reduced, and if the action goes far enough the water will be frozen. This cooling action can be felt by pouring a little ether or alcohol upon the hand. The liquid evaporates rapidly, and the loss of the heat which it takes up cools the hand very perceptibly. If a bottle

* For exact statements as to these decrees of the highest Church and monastic authorities against medicine and surgery, see Sprengel, Baas, Geschichte der Medicin, p. 204, and elsewhere; also, Buckle, Posthumous Works, vol. ii, p. 567. For a long list of Church dignitaries who practiced a semi-theological medicine in the middle ages, see Baas, pp. 204, 205. For Bertrarius, Hildegarde, and others mentioned, see also Sprengel and other historians of medicine. For clandestine study and practice of medicine by sundry ecclesiastics in spite of the prohibitions by the Church, see Von Raumer, Hohenstaufen, vol. vi, p. 436.

containing water is kept wet on the outside with ether, the evaporation will chill the water and eventually freeze it. This is essentially the process by which the *carafes frappées* of French restaurants are produced. The decanters filled with fresh water are set in shallow tanks containing brine, which remains liquid below the temperature at which fresh water freezes. In contact with these tanks are receivers, which can be kept charged with newly formed ether vapor. The chilling vapor cools the brine, and this in turn takes heat from the water in the decanters, which soon freezes.

In making ice on the large scale, either ammonia or sulphurous oxide is used instead of ether, because these substances are cheaper and are not inflammable. Ammonia is a gas or vapor at ordinary temperatures. What is commonly called ammonia, or, more properly, ammonia water, is water with several hundred times its volume of this gas dissolved in it. For ice-making, anhydrous ammonia—that is, ammonia perfectly free from water—is used. The first thing to do is to get the ammonia into the liquid form. There are two ways of condensing a vapor to a liquid—by cold and by pressure. Practically it can be done easiest by combining the two. The ammonia gas is subjected to pressure, and forced through a coil of pipe called a condenser, where it is cooled by water from any convenient supply running down over the pipes. By this means the latent heat in the gas is pressed out, and is taken up and carried away by the water. After being liquefied in the condenser the ammonia is forced into pipes larger than the liquid can fill, where it immediately expands into a vapor and exerts its chilling effect.

Two methods of making ice, which differ, however, in only one step of the process, are now in use. In a factory established last year in New York city, which the writer has been permitted to go through, the "compression system" is used, with anhydrous ammonia as the cooling agent. The machinery employed consists of a powerful pump driven by steam, with which is connected the necessary condensers, piping, etc. Liquid ammonia is supplied by the makers of ice machines in strong iron drums. The ammonia is run into a cylindrical iron tank, from which it is allowed to pass through a small orifice into the coils of pipe in the freezing tank. In this factory the freezing tanks are of iron, about twenty by fifty feet in size, and four feet deep. Over them is a floor, which is cut up into rows and lines of rectangular covers. Each of these lifts up, showing a can under it, twenty-two by eleven inches in size, and forty-four inches deep. The tank contains a brine of regulated strength, and the cans when filled with the water to be frozen float in this brine, coming within an inch or two of the bottom of the tank. Back and forth across the

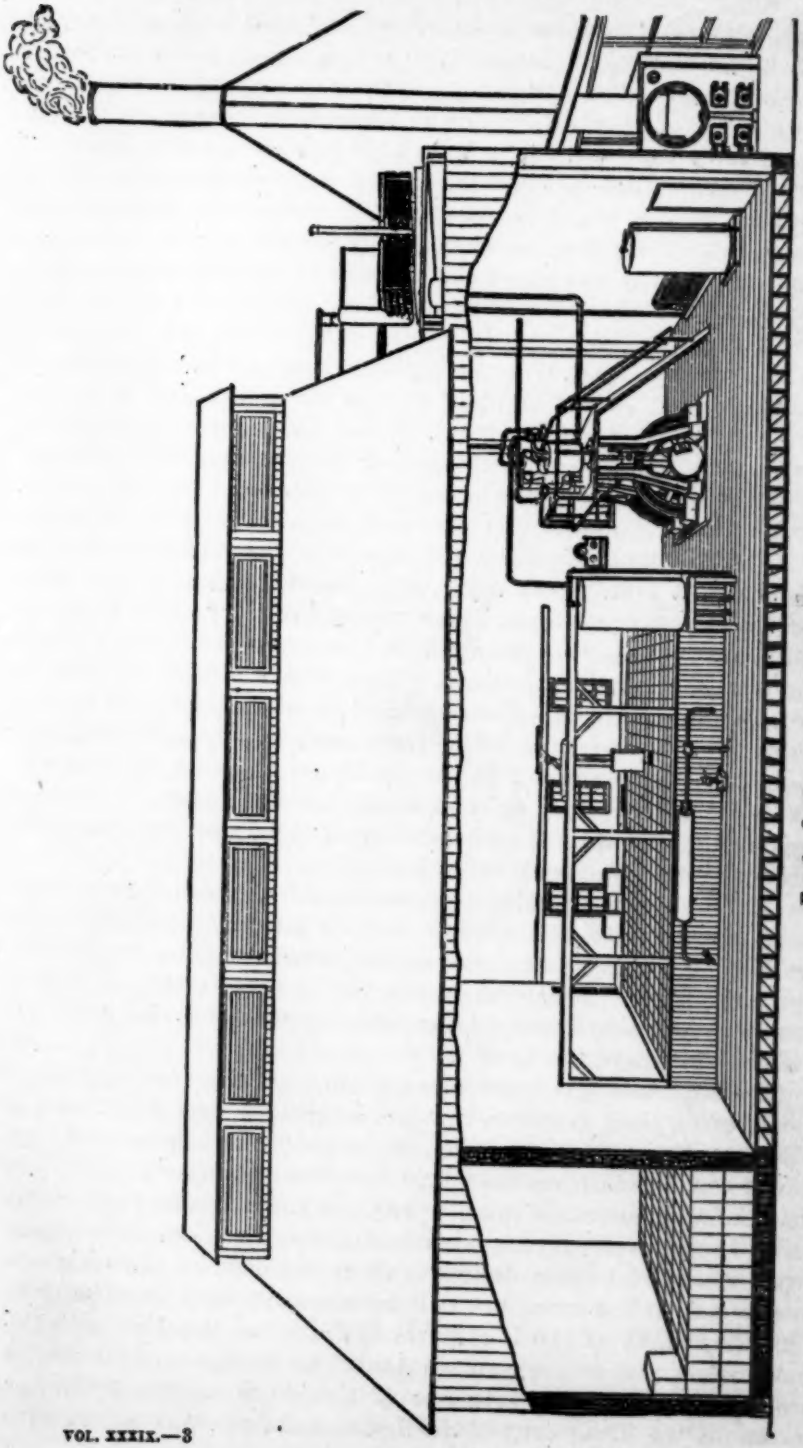

FIG. 1.—INTERIOR OF AN ICE FACTORY.

tank, between the rows of cans, run the coils of pipe through which the ammonia passes. The evaporation of the ammonia constantly going on within this system of pipes cools the brine down to 15° or 18° Fahr. In order to equalize the temperature in all parts of the tank the brine is kept in constant circulation by a revolving agitator, which resembles a propeller-screw. Surrounded by this frigid liquid the water in the cans becomes congealed to uniform hard blocks of ice, weighing about three hundred and twenty pounds each. A tank of the dimensions above given contains five hundred cans. About sixty hours are required for the freezing process.

In Fig. 1 the tank, with its flooring, is shown in the middle of the building. To the right of this is the pump, and at the extreme right is the boiler-room. Over the tank is a traveling crane, by which the cans containing the ice are lifted out and conveyed to one end of the room. The crane consists of a beam, with a pair of wheels under each end, which travel on tracks six or seven feet above the floor. By means of the tackle hung from this beam a man raises a can of ice above the floor, and then pushes the crane with its load to the end of the room. Here the can is put into a sort of swinging box and tilted over into a slanting position, mouth downward. Tepid water is then allowed to run over the can from a line of small jets on each side. In two or three minutes the block of ice is melted free from the can and slides through a shute into the ice-house. The box is an automatic contrivance, and, as soon as the ice has left it, it reverses, turning the can upright and shutting off the water. In some factories the can is dipped into a tank of warm water to loosen the ice. In the figure, a can is seen suspended from the crane; at the back, under the middle window, is the small tank of warm water for dipping the cans; and in front of the next window two blocks of ice are lying. The room at the left is the ice-house. It has double walls packed with non-conducting material, and is shown with two layers of blocks in it.

The ammonia gas, after passing through the coils of pipe in the freezing tank, is drawn through a pipe into the great pump, where by the return stroke of the piston it is compressed and forced out through another pipe into the condenser. In Fig. 2 the condenser is shown in an upper room. It consists of several coils of pipe, over which cold water is kept running. The small pipes which run down obliquely from the ends of the coils are to carry away the ammonia as it becomes liquefied into the storage tank, which is the horizontal cylinder on the floor with the condenser. From the storage tank the ammonia, still under pressure, passes down into one of the large vertical cylinders shown in the lower part of the figure, and from this it goes into

the expansion coils in the freezing tank, and passes again through the cycle of operations just described. The same ammonia is thus used over indefinitely. The pressure to which the ammonia is subjected in this apparatus ranges from one hundred and twenty-five to one hundred and seventy-five pounds per square inch. The pump, shown in the lower part of Fig. 2, is one of several makes. It has two compression cylinders, seen at the top of the tall A-shaped frame. The piston-rods work vertically beneath these cylinders, and are connected by cranks and connecting-rods to the piston working in the steam-cylinder seen at the right. The use of the ammonia in making ice can be compared to the use of a sponge in baling a boat. As the sponge soaks up water from the bottom of the boat, and after being squeezed over the side is ready to soak up more, so the ammonia soaks up, as it were, heat from the water to be frozen; and, after this has been squeezed out by the compressor, the liquid is ready to take up more heat.

The water from which the ice is made in the New York factory, previously mentioned, is from the city supply (Croton). Before being frozen it is purified by filtering and distillation. It is first filtered, then converted into steam in vertical boilers about twenty feet high; the steam is condensed and again filtered in steam filters filled with coke. The condensation is effected by placing the filters in the open air on the roof of one of the buildings, and circulating around them water pumped from the river, near which the factory is located. After leaving the steam filters and condensers, the water is further cooled by passing through a cooler similar to the condenser used for the ammonia. After leaving the cooler, the water is filtered through charcoal, and is then ready to go into the cans. It is filled into them through a hose, which ends in a long nozzle, containing a patented device that prevents air from being carried down into the water. In order to make clear ice, the formation of air-bubbles in it must be prevented. Water always contains some air, which is driven out by boiling. When boiled water is frozen, the ice contains only what little air is absorbed by the water while it is being cooled down to the freezing-point. The artificial ice, therefore, is clear except a thin layer running lengthwise through the middle of the cake—the part that freezes last. A very attractive exhibit for a market is made by putting meat, fish, fruit, and flowers into cans of water and freezing them into the clear ice. Articles having smooth surfaces, and consequently few crevices in which air-bubbles can cling, give the best results.

It was mentioned early in this article that sulphurous oxide is used as a cooling agent in making ice. This is the choking gas that is formed when sulphur burns. An ice machine employing anhydrous sulphurous oxide is made, which, as it works accord-

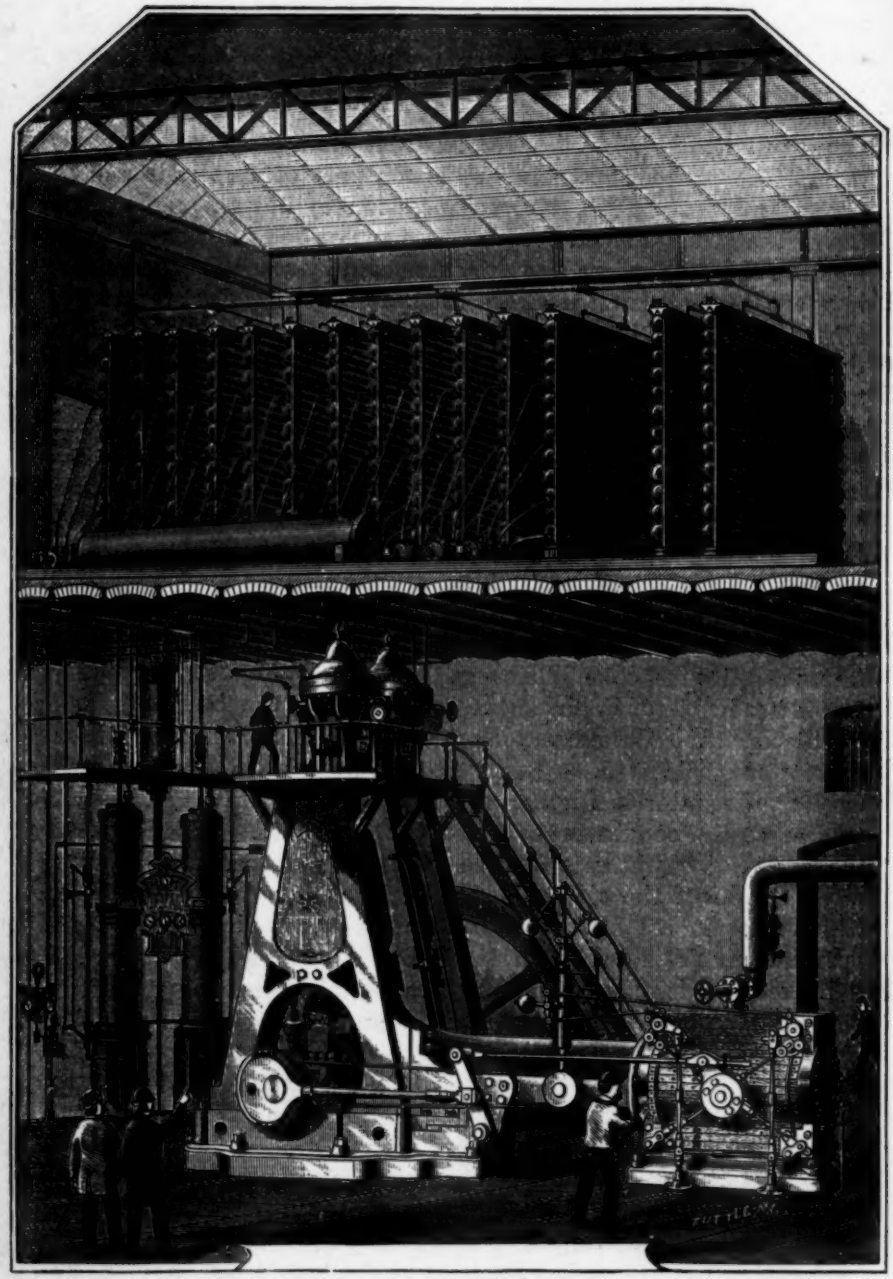

FIG. 2.—AN AMMONIA-COMPRESSION ICE MACHINE.

ing to the "compression system," like the ammonia machine just described, necessarily has the same essential parts, though differing somewhat in form and arrangement. It uses a brine made from magnesium chloride instead of common salt.

There is also a class of ammonia machines, that operate on what is called the "absorption system." In these machines the operation starts with ammonia water instead of anhydrous ammonia. The liquid is heated in a boiler, and a mixture of about nine parts ammonia gas and one part steam is driven off from it. The mixed vapors pass first into a rectifier, where most of the steam is condensed to water, which runs back into the boiler. The temperature in the rectifier is not low enough to condense the ammonia, which passes on, now nearly free from water, into the condenser. Here it is liquefied by the joint action of cold and pressure, only the pressure is not supplied by mechanical means, but by the expansive force of the stream of vapor that is constantly being driven out of the boiler. The liquid ammonia next passes into the expansion coils in the freezing tank, just as in the compression system. After doing its work the gas is led into an "absorber," which is very similar to the condensers already described. Here it is reabsorbed by the water that it was originally driven out of, this water ("poor liquor" it is called) having been forced out of the boiler by the pressure prevailing in it and cooled for the purpose. It is this operation that gives the name to the absorption system. The resulting solution of ammonia is returned to the boiler by a pump and begins again the same round of operations.

In hot climates natural ice is an expensive luxury, as it must be brought long distances, and suffers much loss from melting. In those regions the artificial product has a great advantage in respect to cost. Even where there is usually a cold winter, as in the northern United States, a failure of the ice-crop sometimes occurs in the fields usually depended upon, followed by a more or less necessary increase in price the following summer. Ice machines have now reached such a high degree of efficiency that their product can compete with natural ice in these latitudes. In the summer of 1890 the price of natural ice to families in New York was a dollar a hundred-weight, while artificial ice sold for fifty cents. No doubt further improvements in machinery and methods will be invented, which will make it possible to furnish ice at a still lower price than now, and will lead to a freer and more general use of this commodity. Not only can artificial ice be sold at a lower price than the natural in most markets, but it is more economical, for the reason that it does not melt so fast. This is because it is frozen without the interruptions that allow layers of bubbles to collect under natural ice formed on still water, and it contains no soft snow-ice. It is, therefore, more compact than any but the very best of the natural product.

Another advantage that is claimed for artificial ice is, that when made from distilled water it is free from the impurities

that natural ice sometimes contains. Nearly all natural water contains considerable numbers of bacteria, many of which are derived from the sewage discharged into some lakes and rivers from which ice is cut. It is commonly believed that water in

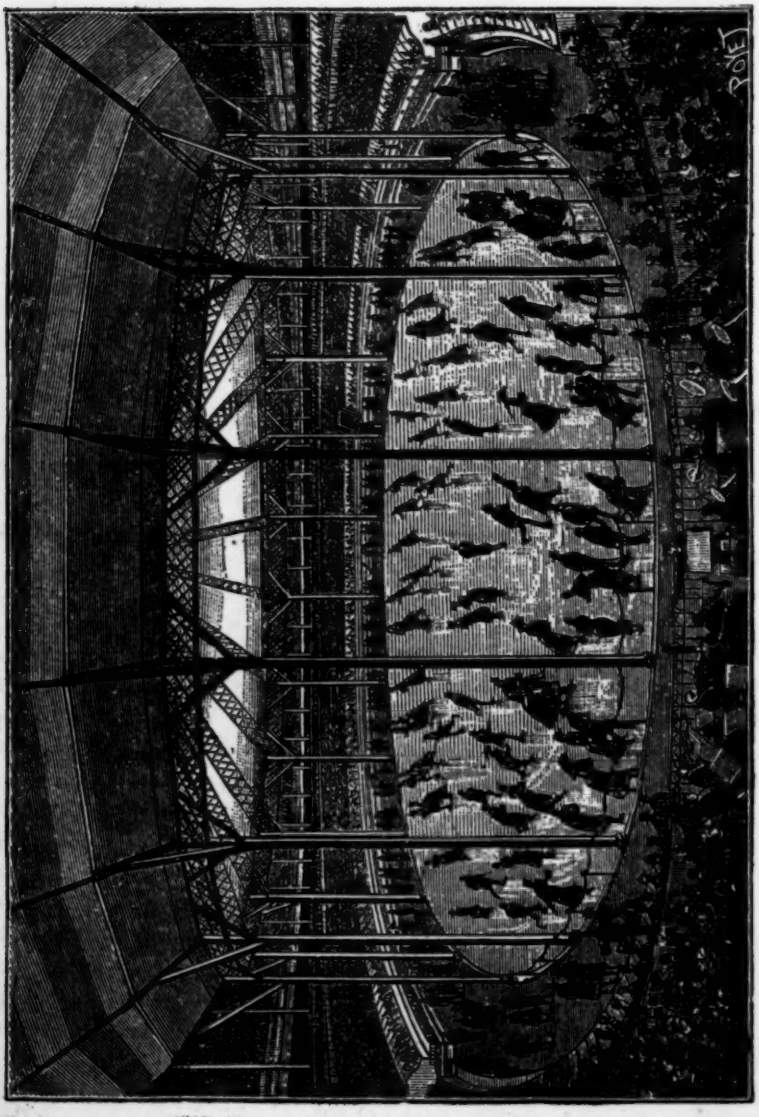

FIG. 8.—RINK OF ARTIFICIAL ICE IN PARIS.

freezing purifies itself from all kinds of contamination, but Dr. T. M. Prudden has shown in this magazine that the truth is otherwise. In his article on Our Ice-supply and its Dangers (Popular Science Monthly for March, 1888) he says:

A great deal of careful experiment has shown that water in freezing largely expels its coarser visible contaminations, and also that a large proportion of the

invisible bacteria which it contains may be destroyed, even as many as ninety per cent. But still large numbers may remain alive, for many species are quite invulnerable to the action of cold. It has been found that in ice formed from water containing many bacteria, such as water with sewage contamination, the snow-ice almost invariably contains many more living bacteria than the more solid, transparent part; so that the snow layer should be especially avoided in ice obtained from questionable sources. Unfortunately, the bacteria which cause typhoid fever are not readily killed by cold, and may remain alive for months, fast frozen in a block of ice.

As the neighborhood of our ice-fields becomes more thickly settled, and the demand for ice also increases, the danger that frozen filth will be served out to consumers of ice will increase likewise. It is fortunate that the artificial process stands ready to shield us from this peril.

Utility has not entirely monopolized the artificial production of ice; it has been made to serve sport as well. About 1875 a Mr. Gamgee, in England, constructed a rink of artificial ice for summer skating, and several others have been made in that country. In 1889 an immense rink of this kind was established in Paris, circular in form and one hundred and seventy feet in diameter. Around the sheet of ice was a promenade over seven yards wide,

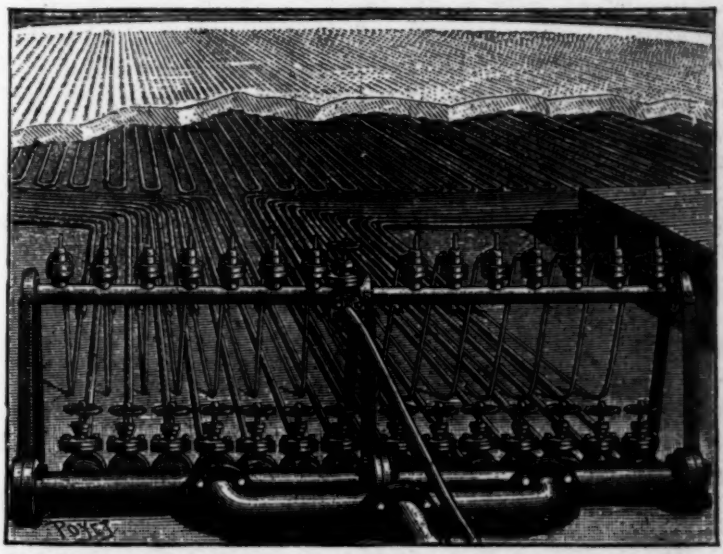

FIG. 4.—ARRANGEMENT OF THE EXPANSION COILS IN A RINK IN PARIS.

and outside of this were placed seats for spectators, a band-stand, etc., the whole being covered by an arched roof. The arrangement of this rink is shown in Fig. 3. The ice-sheet was formed on a concrete bed, upon which lay an immense coil of iron pipe, as shown in Fig. 4, having a total length of ten miles. The pipe

was of an inch and a quarter internal diameter, and the lengths were placed five inches apart. Through this coil the ammonia circulated, the absorption system being used to effect the congelation.

The machines with which ice is made have also another and up to the present time a larger application. This is the production of cold in breweries, abattoirs, markets, and cold storage

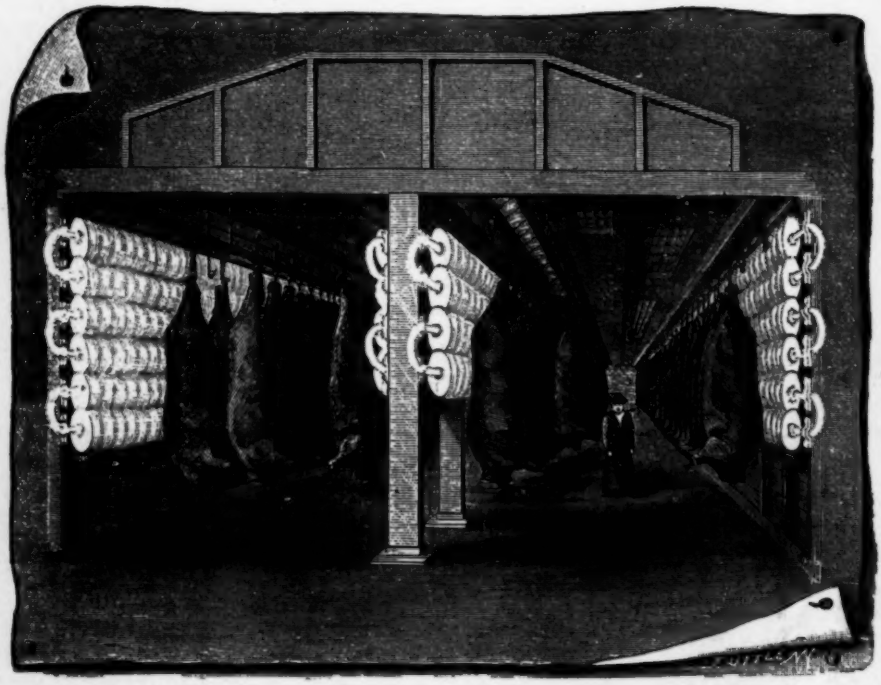

Fig 5.—A Room in a Cold Storage Warehouse.

houses. The fermentation of beer must take place at quite a low temperature, which must be steadily maintained; hence energetic and continuous cooling of the wort has to be provided for. The brewers were formerly among the largest customers of the ice companies, but now nearly every brewery has a refrigerating machine of its own, and more machines are used by them than by all other users put together. No ice is made with these machines, except for packing beer for shipment, as the cooling required can be accomplished more conveniently by circulating cold brine or cold fresh water in pipes where it is needed.

The system of cold storage which has sprung up within the past few years has been made possible by this same process. Immense quantities of meat and other perishable provisions are now kept in great warehouses until wanted, thus insuring a steady

supply to the consumers in our large cities. The provisions, when brought into these buildings, have the temperature prevailing outside, and warm the air that comes in contact with them. This air rises into a loft, where it comes in contact with pipes containing cold brine, becomes chilled, and descends through flues to the room below, entering it near the floor. This circulation goes on until the provisions have been cooled down to the temperature of the room. The air may be cooled, also, without the use of brine, by letting it come in contact with the coils in which the ammonia expands. Air has also been used direct for the production of cold by compressing it. Like condensed ammonia, it takes up much heat in expanding to its ordinary volume, but this system is not economical. In Fig. 5 a somewhat different arrangement is represented. Where there is not space for the loft, the expansion coils may be placed in the same room with the provisions. Before refrigerating machines came into use, refrigeration on the large scale had been tried with ice, and had failed. This was owing to the dampness imparted to the air by the melting ice. The brine or ammonia coils not only do not add any moisture to the air, but even withdraw a great deal that it naturally contains. This moisture becomes condensed on the pipes as the air circulates around them, and makes itself visible as a gleaming white coating of hoar-frost. On board steamers, machines are employed both to preserve dressed meat and to prevent live cattle transported through tropical regions from dying of the heat in their confined quarters. Machines of moderate size also find application in hotels—two of the recently built houses in New York have them—in dairies, chocolate factories, and they are used also in making stearin and margarin, in rectifying alcohol, extracting paraffin from petroleum, etc. A machine of the size represented in Fig. 2 will produce a refrigerating effect equal to that obtained by the consumption of two hundred and twenty tons of ice a day, or it will make one hundred and thirty tons of solid ice daily. The company that makes this style of machine is now building one of three hundred tons refrigerating capacity, which will be the largest in the world. But that is soon to be exceeded, as the contract is already made for a five-hundred-ton refrigerating machine.

Artificial refrigeration has also been applied to sinking shafts and driving tunnels through quicksand and loose wet gravel. These materials wash into an excavation as fast as they are removed, and in many cases progress through them is next to impossible by ordinary methods. The difficulty is overcome by freezing the loose soil around or in front of the work. This process was first used by a German mining engineer in 1883. In sinking a shaft, pipes of about eight inches diameter are driven

down in a ring around the place of the proposed excavation. A brine, cooled to within a few degrees of 0° (Fahr.), is sent down through an inner pipe and returns through the space between the two pipes. By this means a cylinder of the wet earth is frozen, within which the digging is done and the lining of the shaft put in place. The core of the cylinder which is to be removed will be partly or wholly frozen, according to the degree of refrigeration employed. Frozen quicksand looks like a fine-grained sandstone, and is about as hard to cut through.

Those who are acquainted with the history of invention, will not be surprised to learn that the Asiatics were centuries ahead of us in the making of ice, as in the use of gunpowder, the compass, etc. Ice has long been made in India by the following method: Pits two feet deep and twenty or thirty feet square are dug in a large, open field, and about half filled with straw. After sunset shallow dishes of porous clay are placed on the straw and water is poured into them. The rapid evaporation of part of the water, assisted by the radiation of heat from the straw, chills the water remaining, and, if the night is favorable, thin sheets of ice form in the pans by morning. The operation is most successful when the sky is clear and a gentle dry breeze is blowing. Although we of the Western world have clearly been anticipated in producing ice artificially, we may still claim the superior credit that our process has not remained stagnant for generations, but has achieved many of the possibilities that have been open to it, and become independent of such limitations as the state of the weather, and others that hamper the operations of the "gentle Hindoo."*

FORTIFYING AGAINST DISEASE.†

By SHERIDAN DELÉPINE, M. B.

THE intense excitement and the unbounded hopes created by the announcement that a cure for consumption has at last been found have led me to lecture to-day on a subject which I generally relegate to the end of my course of pathology. For, after discussing the various phenomena which are brought about by disease, and attempting to connect these phenomena with their cause, apparent or real, it is natural to try to explain why these

* For the electrotypes of Figs. 2 and 5 in this article I am indebted to the courtesy of the De La Vergne Refrigerating Machine Company.

† On Development of Modern Ideas on Preventive, Protective, and Curative Treatment of Bacterial Diseases, and on Immunity or Refractoriness to Disease. A lecture delivered at St. George's Hospital on November 20, 1890, on the occasion of the publication of Koch's method for the cure of tuberculosis.

causes do not always bring about the results which are observed only in a certain percentage of cases.

EFFECTS OF INDIVIDUALITY, AGE, SEX, FAMILY, RACE, SPECIES.—It is a matter of common experience that in times of epidemics persons equally exposed to infection are not all affected. The weak members of the community are generally more readily affected than the strong ones, the starved than the well fed, the intemperate than the temperate, the fearful than the fearless; but, apart from these often doubtful distinctions, some other influences must be at work in helping some to resist, for many a man or woman of weak constitution has been able to pass through plagues that had carried away more than one of powerful frame. This resistance of some individuals to disease has probably at all times attracted the attention of men, and very early in the history of civilization observations have been made which by gradual extension have led to some of the most striking triumphs of medicine. It will be my object in this lecture to show you how immunity to disease, at first supposed to be due to individual peculiarities or supernatural influences, has gradually become connected with certain external circumstances acting directly or indirectly. Among the factors which are generally discussed in medical books as influencing the liability or immunity of certain individuals to disease I may mention age, sex, family, and race. These, as far as we can see at the present time, have an influence on the occurrence of disease which is in many instances difficult to explain. Some facts, however, tend now and again to lighten our ignorance, and to show that even these apparently inherent qualities are perhaps the result of the transmission of acquired properties through generations of cells or of individuals. This will be more evident perhaps if, by extending our field of observation from one to several kinds, we consider how the immunity of certain species, orders, or even classes of animals is brought about. Take, for instance, the remarkable immunity of the fowl and of the frog to anthrax. At first sight it seems impossible to understand why a small animal like a frog or a fowl should be able to resist a disease that is so rapidly fatal to such large animals as the sheep, man, or even the ox. Pasteur, however, more than twelve years ago recognized that the difference of the body temperature of the various animals was enough to affect the development of the parasite. He immersed a fowl for two days in water, bringing the temperature down to 28° C., and showed that the fowl was as liable to anthrax as any other animal. A similar observation was made later on by another observer, who by raising the temperature of a frog rendered it also liable to the disease. Thus it was demonstrated that certain conditions of temperature were necessary for the anthrax bacillus to attain its full virulence. What

temperature does in these cases chemical products, special to certain animals, can also bring about in others. This is well proved by the influence of various culture media on the growth of microorganisms. The presence of chemical compounds of well-known nature, even in very small quantities, has been shown by a great many observers to influence much the mode of growth of bacteria. It has even been proved that bouillon obtained from the muscular tissue of various animals, notwithstanding the absence of any very definite active chemical compound causing marked difference, gave cultivation media more or less suitable for the growth of certain organisms. I will only mention out of a large number of other observations the very recent experiments of Hippolyte Martin on the *Bacillus tuberculosis*. This observer found that animals can be classified roughly in the following way, according to the ease with which the bacillus grows in bouillon made with their tissues: herring, oyster, mussel, monkey, horse, calf, rabbit, birds, dog, cat, rat. It would be difficult in the present state of our knowledge to ascribe these differences to the presence of any definite compound, yet it can not be doubted that they are due to certain physico-chemical properties. We have thus distinct evidence of marked differences between animals of different classes, orders, and species; and, if we admit the truth of the doctrine of evolution, we must admit that such differences are in great part the result of the influence of external circumstances. We might infer from this that differences between animals of the same species, but of different races, families, sex, or age, are likewise the result of similar influences; we have, however, better evidences than these in support of the view that either extreme liability or immunity to disease may be acquired. Indeed, I shall be able to show you that it is the gradual development of that knowledge which has prepared man for the reception of Pasteur's discoveries, and of their recent momentous extension by Koch.

Refractory State resulting from a First Attack of Certain Fevers.—It was very early recognized that after a first attack of many infectious fevers, such as small-pox, measles, typhus fever, etc., a second attack seldom occurred. This fact seems to have been observed more specially in connection with small-pox, or at any rate to have led to practical application first in connection with that disease. We learn that the *inducement of a first attack of small-pox* was an antique practice in Africa, Persia, and China, and that the method of inoculation was brought from there to Constantinople in 1673, and from that town to England by Lady Mary Wortley Montagu. The idea was evidently to produce a mild attack of the disease in individuals placed under circumstances most favorable to recovery in order to induce immunity. The practice, although open to serious objections, must have had

no little success, and was much resorted to in the middle of the last century. Another practice which is not so rare as one might be inclined to believe is the *inducement of measles.* Many people are under the impression that unless children have had all the ordinary exanthematous fevers it is almost desirable that an opportunity should occur for them to have mild attacks of these fevers; and I have known of instances in which, one out of several children being attacked with measles, no attempt has been made to isolate the sick child, for, it was argued, it was as well for the other children to have the fever also and be done with it as soon as possible. Since this has been done under the influence of a popular belief, I think I am justified in suspecting that the practice of inducing measles for protective purposes is far from uncommon, although not generally carried out by professional men. Boeck and Sperino introduced about 1854 the practice of *syphilization,* and these authors recognize clearly that this method is not only a prophylactic, but also a truly therapeutical one. The inducement of a certain disease in order to prevent its recurrence, and even to modify the course of an attack, was therefore a method early recognized in this century both in connection with smallpox and syphilis.

Refractory State produced by Inoculation of an Allied Disease less Fatal, or of the Disease modified by Passage through another Animal.—Certain country people had early suspected that a disease affecting cows was communicable to man, and that individuals thus affected were not so liable as other people to smallpox. History tells us that an English farmer and a German schoolmaster in the course of the last century, under the influence of that belief, had resorted to inoculation of that cow disease in preference to the inoculation of true variola. Jenner was the first medical man who discovered the immense importance of these traditional beliefs and practices, and after devoting all his energy to the study of the subject became so convinced of the value of the method of vaccination that after a long struggle he has succeeded in convincing others, and has become thus one of the greatest benefactors of the human race. From 1798—when Jenner brought vaccination before the world—up to 1880 very little was done to extend the scope of the principle thus discovered. Then Pasteur arose, who, after studying for many years the nature of the virus causing several diseases, became gradually convinced that this virus may become intensified or attenuated at will, and in 1880 was able to state positively that the production of an attack of definite intensity of many infectious diseases was a thing not only possible, but also practicable and capable of application for the prevention of disease. In 1880, also, Burdon Sanderson suggested that the attenuation of the virus of anthrax for

the purpose of vaccination might be obtained by using the guinea-pig as an intermediate host. Greenfield experimented also at the same time and in the same direction with very satisfactory results. In 1883 Pasteur and Thuillier made experiments in the *rouget des porcs*, showing clearly that by causing the virus to pass through a series of pigeons it became gradually more virulent for the pig; while the reverse was true when series of rabbits were used as intermediates, showing thus at the same time how disease may originate or be modified. The principle of vaccination as introduced by Jenner seemed therefore to have become a fact capable of general application by this time. All that seemed necessary was to find a suitable intermediate host for the parasite. By growing the parasite in a series of such intermediate animals one was able to obtain a "vaccine" or "lymph," which, like that of vaccinia, was capable of inducing immunity, as well as an attack of the unmitigated disease would have, but without the same danger. Another fact of great importance has also been noticed by several observers—viz., that the occurrence of certain febrile affections may modify the course of other febrile affections previously established. Daniellsen and Boeck were perhaps the first to notice this fact, and to record the beneficial influence which an attack of small-pox might have on the course of tubercular leprosy. I need not refer to the numerous attempts which have been made since in that line.

Refractory State produced by Inoculation of a Virus modified by Cultivation outside the Body.—Another discovery, more fertile in results, although similar in principle, was, however, made known by Pasteur in 1880. He showed that by cultivating the microbe causing chicken cholera at a temperature of 33°, with free access of oxygen, he could obtain in from two to eight months an attenuated virus, which would cause the disease in a form mild, but sufficient to produce immunity. Toussaint and Chauveau were experimenting at the same time on the anthrax bacillus. Toussaint made the important discovery that, by heating cultivations of the *Bacillus anthracis* rapidly to a comparatively high temperature, its virulence was attenuated. In 1881 Pasteur produced attenuation of virulence of the *Bacillus anthracis* by cultivation for nine days at a temperature of from 42° to 43° C., and produced immunity by vaccination with the modified virus. Koch, Gaffky, and Loeffler repeated Pasteur's experiment in 1884, confirmed his results, and extended them, differing from him only with regard to the influence which he attributed to oxygen. In 1882 Pasteur and Thuillier applied to the bacillus of "rouget" the same principle as that used in the case of the chicken cholera and splenic fever, and succeeded in attenuating that virus also. During the whole of this period Pasteur was occupied in trying to

isolate the virus of rabies. Although he did not succeed in doing so, he discovered that the nervous tissues acquired in that disease virulent properties which indicated the presence in them of some unknown virus. Not being able to obtain the virus itself, Pasteur used the nervous tissue as he would have a nutrient medium, and having discovered the method of obtaining spinal cords having a constant virulence (fixed virus), he dealt with these cords in the same way as he would have with ordinary cultivations, and thus succeeded (1885) in attenuating the virus and being able to produce immunity by vaccination, as in the case of the other diseases. Many other methods have been proposed for attenuating the virulence of organisms than those introduced by Pasteur. We have already seen how Toussaint and Chauveau used rapid heating. Paul Bert showed that oxygen under high pressure (twenty atmospheres) kills the *Bacillus anthracis.* Toussaint, Chamberland, and Roux (1880–'86) added dilute carbolic, chromic, and sulphuric acids to nutrient media for the same purpose. Klein (1888) used also very small quantities of corrosive sublimate for the same purpose. Arloing (1886) showed that bright sunlight has also an attenuating effect on cultivations in fluid media. It is useless to go into the further developments of these methods, that of Pasteur being the only one which has had very extensive application as yet so far as man is concerned.

Refractory State produced by the Introduction into the System of Definite Chemical Products resulting from the Action of Pathogenic Organisms on Cultivation Media.—Salmon and Smith (1883) seem to have been the first to realize the practical importance of the injection of the products of growth of organisms independently of the organisms themselves. They showed that the injection of cultivations of the microbe causing hog cholera produces the effects of attenuated virus after being sterilized by heat, at any rate in the case of pigeons. (It was, however, accepted before that time that micro-organisms generate products which are deadly to themselves and are capable of arresting their growth, a fact which has also long been known in connection with fermentation organisms.) Pasteur very early showed also that filtered chicken-cholera bouillon injected into a bird produced the symptoms of the disease, although no organism was present in the fluid. He showed also that the same is true of the blood of animals affected with anthrax.

In attempting to explain the effects of inoculation with spinal cord for rabies, Pasteur also alluded, in 1885, to the probable existence of some chemical compound in the cords which he used for protective inoculation, and suspected that this compound was instrumental in bringing about immunity. It was only about 1887 that these facts and views acquired fresh significance by

the work of Toussaint, Chauveau, Wooldridge, Chamberland, and Roux on anthrax; of Charrin on the pyocyanic bacillus disease, of Chamberland and Roux on acute septicæmia, etc.; of Brieger, Chantemesse, and Vidal on typhoid fever; of Roux on symptomatic anthrax, and of Roux and Yersin on diphtheria. In most of these experiments the material used for inoculation was the cultivation medium modified by the growth of the organism, and sterilized either by heat, by filtration, or by both methods. The work of Charrin, Woodhead, Cartwright, and Wood has also shown that protection may sometimes be obtained not only by injection of the products of the growth of the pathogenic organism itself, but also of some quite different ones (*Bacillus anthracis* and bacillus of blue pus).

The products used were therefore of a very complex nature, and it was not known to what kind of compound they owed their property of conferring immunity. Roux and Yersin had, in 1888, tried to prove that their chemical vaccine for diphtheria owed its properties to an albuminoid body allied to unorganized ferment, but this last supposition is not generally accepted, although not disproved. (In order to understand the origin of the following improvements it is important to remember that the work of Panum (1856), Gautier and Selmi (1873) had revealed the production of very poisonous alkaloidal substances during putrefaction. The more accurate researches of Nencki, and still more of Brieger, demonstrated clearly the existence of an important class of poisonous alkaloids produced by the micro-organisms of putrefaction. Gautier (1881), on the other hand, was trying to prove that animal tissues are also capable of producing by their metabolism poisonous substances of allied nature. The experiments of Lauder Brunton and Sir Joseph Fayrer on cobra poison (1873) should be kept in mind in relation with this subject. It was soon found that, besides these poisonous albuminoids, other more or less poisonous products might be manufactured either by animal or vegetable cells; these products were found to belong to the ill-defined class of albumoses. I need only refer to the work of Weir Mitchell (1860) and Reichert on the albumoses of snake poison; of Sydney Martin on phytalbumoses—i. e., albumoses produced by vegetable cells, whether bacterial or others—an important work, which led him to infer later on that albumoses were products intermediate between the non-poisonous albuminous substances of the culture media and the most poisonous alkaloids. Büchner, Wooldridge, Hankin, and others were also discovering toxic albuminous substances in various fluids or tissues of the body, some of which were deadly to bacteria.) Returning now to preventive inoculation, we find that in 1889 Sydney Martin in London, and Hankin of Cambridge, working in Koch's and Brieger's laboratories, had

isolated from cultivations of the *Bacillus anthracis* albumoses which were found by Hankin to produce immunity from the disease when injected into the body. Possibly under the influence of Hankin, *certainly later in the year*, the important researches of Fraenkel and Brieger on the toxalbumins of diphtheria, typhoid fever, cholera, tetanus, etc., were published. Thus, just as in the case of many remedies used for centuries in the shape of powders, extracts, decoctions, infusions, tinctures, etc., active principles have ultimately been discovered by chemists, *it was now found that out of the material used for the last ten years by Pasteur and his school, it was possible to isolate some active products of definite composition*, to which the lymphs or "vaccins" owe their prophylactic and curative properties. Such was the state of science when, in the course of last year, it was announced that Koch had found the means of curing phthisis by inoculation. All minds were to a certain extent prepared for such an announcement; yet the fact that one of the greatest scourges affecting human kind had at last come within the pale of treatment has created immense sensation. The little that is known of the treatment and of its effects seems to point clearly to the fact that Koch is using some of the chemical products which have just been discussed, and therefore there is good reason to expect that *a certain amount of success* will attend the method. The results of previous experimenters show, however, that it would be wrong to hope too much from a system which has always been attended with *a certain proportion of failures.*

I have carefully avoided in this *exposé* to enter into many details, some of which are of great importance, in order that you should be able to follow the main line of observations and thoughts which have led to the recent discovery. I will therefore not attempt to discuss on what basis vaccination, essentially prophylactic in principle, may become a curative method when the modified virus answers certain requirements. There is a very distinct connection between these two methods of treatment.* It may, however, be interesting to consider for a moment the methods which the knowledge of pathogenic organisms has introduced in medicine.

These methods can be subdivided into three classes: (1) The preventive, (2) the protective, (3) the curative. They have all something in common, and yet they all differ, as will be seen in the following brief enumeration:

1. The *preventive method* consists in *destroying or attenuating*

* For explanation as to the mode of action of the products used in vaccination, see Lauder Brunton's lectures on Chemical Structure and Physiological Action, especially Lecture II (British Medical Journal, vol. i, 1889, p. 1389).

the cause, or avoiding it in some way or other so that the body may remain unaffected. (*a*) The *antiseptic method* introduced by Lister is a good instance of the methods which aim at *destroying the cause* before it has acted. (*b*) *Residence* in high localities, *drainage,* etc., are instances of the methods by which the causes of disease may be so *attenuated or diluted* as to become harmless. (*c*) *Absolute cleanliness. Aseptic* methods are based on the possibility of avoiding certain causes entirely without destroying them.

2. *Protection* consists in so *modifying the possible host* as to render it able to resist virulent parasites. This can be done either by (*a*) increasing its *strength* and activity, as by diet, warmth, functional activity, and other hygienic conditions (Wargunin); (*b*) rendering its tissues and fluids *unsuitable media* for the *growth* or *full development* of the parasite—*inoculation* and *Jenner's vaccination* are good instances of that method, which has been further extended by Pasteur and others; (*c*) by establishing *tolerance* (Sewall, 1887).

3. The *curative methods* consist in *attenuating* or entirely destroying the virus causing the disease *after it has penetrated into the body.* (*a*) The *actual destruction of the parasite within its host* is apparently still a desideratum. (*b*) *Attenuation of the virulence* can be obtained by introducing into the blood and tissues some product either interfering with the full development of the parasite or modifying the tissues and fluids of the body so as to increase their resistance to the extension of the parasite or to its products. This seems to be the chief principle at the root of Pasteur's *vaccination* for hydrophobia, etc. (*c*) *Neutralizing the physiological action of the virus by using its physiological antagonist.* Muscarine, for instance, may be antagonized by atrophine. Lauder Brunton (1873) directed attention to the possibility of applying this principle to the treatment of cholera. (The same idea has been applied to the treatment of poisoning by snake venom. Wynter Blyth, 1877; Lacerda, 1881.) (*d*) *Destroying and removing the substratum* or ground which has become contaminated by the parasite. This is *apparently the view which Koch has taken of the action of his lymph.* The action of the product on the tissues is, however, of the *same kind as that of the substances used in some of the methods already mentioned,* but more intense, and Koch's views will probably have to be modified.

In this attempt to analyze the methods which have been proposed I have separated processes, many of which may act concurrently. This is, however, of little consequence, for my object was less to give an account of any single method than to trace the development of the ideas which are at the basis of the treatment of

bacterial diseases. In this way I hope I may have been able to show you how *science* prepares the way for the highest branches of the *art*—viz., *preventive, protective, and curative medicine.*—*London Lancet.*

SOME GAMES OF THE ZUÑI.

By JOHN G. OWENS.

PLAY finds its best exemplification in the Indian of the Southwest. Living in a mild and genial climate, naturally shiftless and improvident, this true child of Nature consumes his exuberant vitality by play instead of work. Step to the bank of the Zuñi River on one of those supreme mornings in August, which only the matchless climate of New Mexico knows, and you will behold a sight which for genuine mirth and romp will surpass that of any Eastern outdoor gymnasium or children's park. The river, a stream of less than ten feet, winds like a serpent through a sandy bed about one hundred feet wide. This river-bed is the chief playground of the Zuñi child. Here boys and girls, some clad, some with only ear-rings or a chance necklace, are bathing, racing, wrestling, throwing sand, perchance riding some razor-backed hog; everywhere are life and merriment. I think it worthy of note that not once during the whole summer did I see a quarrel of any kind.

This spirit of playfulness remains with the boys and characterizes their later life. Not so with the girls. These, to the age of thirteen or fourteen, are very jolly and playful, but after that they begin to age very rapidly. This is probably the result of early marriage, a custom of the tribe. Zuñi seems to have no class of buxom young women; the transition is from joyous, frolicsome girlhood, to sedate and sober womanhood.

But, beside these sports of childhood, there are a few games which deserve our attention. They are not limited to any age, but, so far as I know, are confined to the male sex.

Before describing these games I wish to acknowledge the kind assistance of Mr. D. D. Graham, the trader—a gentleman of culture, who has lived among the Zuñis many years, and is perfectly familiar with their language. Although some of these games are seldom played in summer, yet through his co-operation I have witnessed nearly all of them.

Pō-kĕ-an.—This game is somewhat similar to our popular game called battledoor and shuttlecock. Green corn-husks are wrapped into a flat mass about two inches square, and on one side are placed two feathers, upright; then, using this as a shuttlecock and the hand for a battledoor, they try how many times

they can knock it into the air. Some become very skillful in this, and as they return the shuttlecock to the air they count aloud in their own language—*Tō-pa, quĭl-ē, hī, ă-wē-ta, ap-ti*, etc. The striking resemblance to our European game suggests a common origin, and it may easily have been introduced through contact with the Spaniards. This, however, is doubtful, and I am inclined to think that we must give the Indian the credit of inventing this game rather than borrowing it, as similarity of product by no means proves identity of origin.

Shō-wē-es-tō-pa.—The number of players is unlimited. Each one has several arrows. One throws an arrow on the ground eight or ten feet in front of him, the others follow in turn, and, should the arrow thrown by any one cross that of another at the beginning of the feathers, he takes it. The limits of success are very small, and skillful throwing is required to win the arrows of another. This game is but little played at present, and I am doubtful whether the younger men of the tribe know how to play it. José California (so named because he made a trip to California on a burro) played it for me. The decline of the game is probably due to the decline of the use of the bow and arrow, but I think it has left a descendant in

Lō-pō-chē-wā.—This is played only by the boys. Instead of arrows they use pieces of bone two or three inches long with feathers tied to them. You may see five or six boys playing this game in all parts of the pueblo at any time during the summer. They generally touch the bone to the tongue before throwing it, to make it stick. The principle of the game is the same as that of the one just described.

Than-kā-lā-wā.—This game is usually played in the spring, and resembles somewhat our game of quoits. In place of the ordinary quoit they use flat stones. Any number may take part. A small stone or even a corn-cob is set up, and on this each places his stake. To determine who shall pitch first, they all throw for some distant point. He who comes nearest to the mark chosen pitches first, and each one follows according to his throw; then the game begins. The distance pitched is nearly one hundred feet. The object is to knock over the stake or pool. If the pool is knocked over, and the stone pitched goes beyond it, it counts nothing; if just even with it, the one who pitched has another chance; if it remains behind, he takes everything, and all put up again. They count it great sport, and some become very skillful in pitching.

*A-we-wō-po-pa-ne.**—This is played by only two persons, but each usually has several backers, and considerable betting is

* There is a slight resemblance in this contest to our sport, the potato race.

done. One place is designated as the stone-home. One hundred stones are placed in a row a certain distance apart. Each stone must be picked up and carried separately and placed, not thrown, in the stone-home. Another point, several miles distant, is taken, and the game is for one to run to the distant spot and return, while the other gathers up the stones. As it is a contest of speed and judgment, not chance, it becomes very exciting.

This almost inordinate desire for play, which I have claimed for the Zuñis, seems not to be of recent origin. The three games, *shō-wē-es-tō-pa, shō-lē-wā,* and *ti-kwa-we,* were "played by the Zuñis as soon as they came out of the ground," as one expressed it. That this expression may be better understood, I will quote from Mrs. Stevenson's article on The Religious Life of a Zuñi Child:* "Let us follow the Zuñi tradition of the ancient time, when these people first came to this world. In journeying hither they passed through four worlds, all in the interior of this, the passage-way from darkness into light being through a large reed. From the under world they were led by the two little war-gods, Ah-ai-ū-ta and Mā-ā-sē-we, twin brothers, sons of the sun, who were sent by the sun to bring these people to his presence. They reached this world in early morning, and seeing the morning star they rejoiced, and said to the war-gods, 'We see your father, of whom you have told us.' 'No,' said the gods, 'this is the warrior who comes before our father'; and when the sun rose the people fell upon the earth and bowed their heads in fear."

Shō-lē-wā.—This game was played for me by Boots and José California. They have four pieces of reed about four inches long. These are differently marked; on the concave side, painted in places, and on the convex side marked with carvings, as shown in Fig. 1. Each piece is named. The one whose concave side is en-

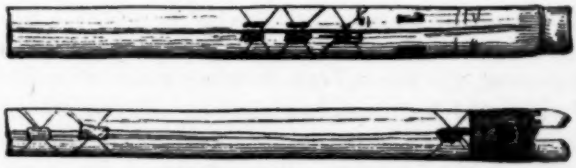

FIG. 1.—REEDS FOR PLAYING SHŌ-LĒ-WĀ.

tirely painted black is called *quin,* the Zuñi for black; the one with one black end, *path-tō;* with two black ends, *kō-ha-kwa;* and the one with a black center, *ath-lu-a.* Fig. 2 shows the manner of holding these pieces when about to play. They are held in the right hand, and thrown up against a suspended blanket and

* Fifth Annual Report of the Bureau of Ethnology.

allowed to fall on another blanket. Two of the pieces belong to each man and are companions. The manner in which the sticks fall determines the result. There is a pool with twelve markers in it, and he who wins the markers wins the game. The winner takes the twelve markers up into his hands and breathes on them. This is because they have been good to him and allowed him to win. It is wholly a game of chance, and horses, guns, saddles, and everything are staked upon the throw.

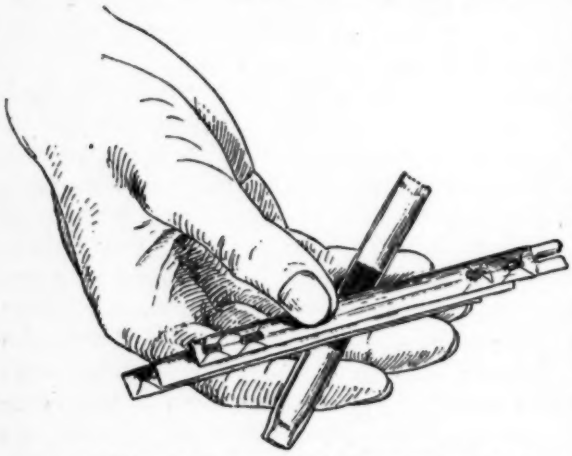

FIG. 2.—MANNER OF HOLDING THE REEDS IN SHŌ-LĒ-WĂ.

Tash-a-lē-wā.—This is a game of chance, is played by two, and is very popular. The players sit on the ground, with a ring of forty small stones, in four sections of ten stones each, between them. The ring is usually several feet in diameter. In the center is a large flat stone called *a-rey-ley*, upon which the players make their throws. The dice, *ta-mey*, are small flat sticks about three inches long, and painted red on one side. These are taken in the right hand and thrown endwise on the central stone. If the three red sides turn up, the player scores ten and gets another throw; if the three white sides, he gets five; two red and one white, three; two white and one red, two. For counting, each player has a stick called a horse, or *touche*. Starting from the same interval in the circle of stones, each player moves his marker over as many stones as he has won points. Should the two meet at the same interval, the second one coming there will send the first one back home, and he must begin over. The idea, as given by the Indians, is, that the new-comer has dismounted or killed the first one. The horse is supposed to stop and drink at the intervals between the groups of stones. One game which I witnessed had loaded rifle-cartridges for stakes. Each player places his bet within the circle of stones.

*Ti-kwa-we, or Game of the Kicked Stick.**—This is the great

* This game was described by Mr. F. Webb Hodge, in the Anthropologist for July, 1890. I have thought well to repeat it here in connection with the other games, and also to make some corrections and add several points which Mr. Hodge seems to have overlooked.

national game of Zuñi. Among Zuñi sports it ranks as base-ball does among our own. It is indulged in by almost the whole male population, from boys of five or six to men of forty. Any evening of the summer one can see crowds of twenty or thirty boys skirting the southern hills and kicking the stick. Practiced thus during eight months of the year, they have an especial occasion when they contest for the championship, and this is one of the great jubilees of the tribe. Although the women do not take part, yet they show equal interest with the men and become as much excited.

The time of holding this contest is usually in the spring between the planting of the wheat and the corn. The Priest of the Bow makes six prayer-plumes and six race-sticks. The prayer-plumes consist of small sticks with the white feathers from the tail of a certain species of hawk tied to one side; the race-sticks are about the size of the middle finger. The priest then takes these sticks and places them on the trail toward the south, and for four days they remain there untouched. At the end of this time he, and any others who wish to join in the race, will run out to where the sticks have been placed, and as they arrive they breathe on their hands and then kick the sticks home, making a circle of two or three miles.

Four days later a representative of each clan, each with a picture of his clan painted on his back, will run out in much the same manner. By this time most of the people have returned from their wheat-planting and the *ti-kwa-we* is in order. At present there are six *estufas* in Zuñi—*Ha-e-que, Ha-cher-per-que, Choo-per-que, Moo-ha-que, O-ha-que,* and *Uts-ann-que.* The contest lies between the members of these different *estufas,* and not between the members of the different clans or parts of the pueblo, as has been stated by some writers.

Whatever *estufas* wish to contest select their men. When the men have been selected it is announced in the evening from the house-tops. This generally takes place three or four days prior to the race. This race is generally held at Zuñi, but may be held at one of the farming pueblos, as Pescado, Ojo Caliente, or Nutria; in any case it is *estufa* against *estufa.* On the evening of the day before the race each side sends for a Priest of the Bow. Upon arrival he puts into the mouth of each one a piece of glass about one inch long; and with some sacred meal, taken from his pouch, he paints a mask on each one's face, then blesses them, and they repair to the hills three or four miles distant. They depart in absolute silence. Not a word may they speak unless they hear or frighten some wild animal in front of them. If the sound comes from behind, it is considered an ill omen. Having reached the hills, they dig a hole about the length of the arm

and deposit in it some sacred meal, native tobacco, *hewe*, shells, and other things held valuable by the Zuñis, and then retire a short distance and do not speak above a whisper. In a little while one will start for the pueblo, saying nothing, and the rest follow in single file. As they return, any manifestation of power, as thunder or lightning, is considered a good omen, as it will make them strong.

The priest who blessed them before they started awaits their return and accompanies them to the house of one of the racers or that of any member of the same *estufa*. As they reach the door of the house, those within say, "Have you come?" "We have," they reply. "Come in and sit down." The priest then blesses them, and a single cigarette is made of native tobacco and passed among the number. Then they retire for the night. Next morning everything is alive in Zuñi. Indeed, for several days past the whole population has been somewhat excited over the coming event. Every one takes sides, from the gray-haired old warrior, who believes the *ti-kwa-we* to be the greatest game ever held, to the blushing maiden whose lover is one of the contestants. Excitement runs high, and the gambling disposition of the Indian has its fullest encouragement. The small boy meets his playmate and stakes all his possessions. The veteran gambler once more tries the turn of fortune, and to counteract his heavier betting he makes a longer prayer to Ah-ai-u-ta or plants an additional plume. The contestants themselves engage in betting, and every conceivable thing of value to an Indian is either carried to the plaza, south of the old Spanish church, where it is put up against something of equal value held by an opponent, or is hurried off to the trader's store and turned into money. Ponies, sheep, goats, money, beads, bracelets, all are wagered. Sometimes also they sell the race. This is not generally admitted by the Zuñis, but I have it on good authority that it has been done.

The day for the race has arrived; the runners have been up since early morning, and have taken a spin over part of the course. During the morning nearly all the members of the *estufa* drop in to tell them how much they have wagered on their success and to encourage them. About an hour before the time to start they eat a little *hewe*, or paper bread, soaked in water. *Hewe* is one of the chief breadstuffs of the Zuñis, and a good *hewe*-maker is in reputation throughout the tribe as a good pastry-cook is among us. *Hewe* is made from corn batter spread with the hand on a large flat stone over a slow fire. It takes but a moment to bake it, is almost as thin as paper, very crisp, and will vary in color according to the color of the corn used. This repast of *hewe* is accompanied by a piece of humming-bird, as the flight of that bird is so very swift.

The runners then bathe in a solution made from a root called *que-me-way*. The time for the contest is at hand. The every-day attire is exchanged for the simple breech-clout. The hair is done up in a neat knot on the top of the head, and the priest pronounces a blessing as he fastens in it an arrow-point, the emblem of fleetness. He then places a pinch of ashes in front of each racer, and, standing before him, holding an eagle-wing in each hand, he first touches the ashes with the tips of the wings and then brushes the racer from head to foot. Then turning to the north he touches the wings together and says a prayer, the same to the west, south, east, the earth, and sky. I suppose the idea of the Zuñi in this to be, that as he has sent a prayer to the four points of the compass, the earth, and sky, he has cut off every possible source of misfortune and danger.

Everything being now ready, the priest leads his favorites to the course across the river. Excitement in the pueblo has reached its height; the most venturesome are offering big odds in the plaza, and now all assemble to see the start.

Should a side be at all doubtful of its success in the race, an old woman is procured to sit and pray during the entire race. She sits in the middle of the room. The racers sweep the floor around her and then pile up everything that is used about the fire, such as pokers, ladles, stirring-sticks, and even the stones used to support the pots during cooking: these are to make their opponents warm; also the mullers with which they grind the corn, and the brooms: these will make them tired. A woman is chosen rather than a man, because she is not so fleet of foot. Similar ideas are found among many other peoples.

"It is a world-wide superstition that by injuring the footprints you injure the feet that made them. Thus, in Mecklenburg it is thought that if you thrust a nail into a man's footprints the man will go lame. The Australian blacks held exactly the same view. 'Seeing a Tatūngolūng very lame,' says Mr. Howitt, 'I asked him what was the matter? He said, "Some fellow has put bottle in my foot." . . .' The Damaras of South Africa take earth from the footprints of a lion and then throw it on the tracks of an enemy, with the wish, 'May the lion kill you!'"*

As each side is brought to the course the priest gives a parting blessing, and the runners take their positions opposite their opponents in single file along the course. The *tik-wa*, or stick to be kicked, is about the size of the middle finger. That belonging to one side has its ends painted red and that of the other side its center painted red, so they may be easily distinguished. The rear man of each file places the *tik-wa* across the base of his toes and sprinkles a little sacred meal upon it. Surrounding the racers

* J. G. Frazer, in Folk Lore, June, 1890.

will be three or four hundred mounted Indians dressed in the gayest colors. All is now ready; each rider has his eye on his favorite side, an old priest rides in advance and sprinkles sacred meal over the course, the starters kick the sticks, and the wildest excitement prevails. As each racer left his home he put into his mouth two shell beads—the one he drops as a sacrifice as he starts, the other when he has covered about one half the course. The stick is tossed rather than kicked, and a good racer will toss it from eighty to one hundred feet. Over the heads of the runners it goes and falls beyond the first man. He simply points to where it lights, and runs on. The next man tries to kick it, but should he fail to get under it he goes on, and the next man takes it. The race is not to the swift alone, although this has much to do with it. The stick can in no case be touched with anything but the foot, and should it fall into a cactus bush, a prairie-dog hole, or an *arroyo*, much valuable time is lost in getting it out. Not infrequently it happens that one side will be several miles in advance of the other when the stick falls into some unnoticed hole. The wild and frenzied yelling which takes place as those who were behind come up and pass can only be imagined and not described. So skill in tossing it plays a prominent part. On, on they go to the southern hills, east to Ta-ai-yal-lo-ne, north to the *mesas*, follow these west for miles, then to the southern hills, and back again to the starting-point. The distance traversed is nearly twenty-five miles, and they pass over it in about two hours. Racing is indulged in by the excited horsemen as they approach the goal, and it is not unusual to see a pony drop over dead from exhaustion as they near the village. The successful runner crosses the river and runs around the heap of wagered goods near the church, then, taking up the *tik-wa* in his hands for the first time, he inhales, as he thinks, the spirit of the *tik-wa*, and thanks it for being so good to him. He then runs to his home, and, if he finds a woman awaiting him, hands the stick to her, who breathes on it twice, and he then does the same. Returning it to the woman, she places it in a basket which she has ready for it; and the next day one of the racers wraps it up with some sacred meal in a corn-husk and deposits it about six inches below the surface of the ground in an *arroyo*, where it will be washed away by the rains.* Meanwhile the winners have claimed their stakes, and, should another *estufa* have a set of men to put up, the winners of the first race must compete with them until all have had a chance, and the great Zuñi races are over for that year.

* This reminds one of our custom of burying certain things under the drop of the house, or throwing them in streams, for the purpose of curing certain diseases. To-day the Zuñian plants his prayer-plumes in the water-courses. Can it be that our custom had a religious origin?

Kle-tak-wa (*Rabbit-hunt*).—Communal hunts seem at one time to have been held by many of the Indian tribes, and are described by the early Spaniards. Many of them were nothing less than a wholesale slaughter. Whether the Zuñis ever indulged in them to that extent I am unable to say, but I saw a fence about fifteen miles to the southeast of Zuñi which, I was told, extended for seventy-five miles, and was formerly used to direct the herds of antelope to a certain place. The presence of the fence suggests the possibility that formerly such hunting expeditions may have taken place there, as Livingstone describes in southern Africa. The rabbit-hunts are described by the early Spanish chroniclers, and are still held by at least the Zuñis and Moquis. Undoubtedly at one time they had a considerable religious significance, but to-day they have more the nature of a frolic.

The Zuñis have eight rabbit-hunts a year—four by the Coyote people and four by the Eagle people. The time of holding them is fixed by the chief of the rabbit-hunts. Although held under the especial direction of particular clans, yet nearly all the male inhabitants take part. I will describe the one in which I took part last August.

FIG. 3.—THE START FOR THE RABBIT-HUNT.

One evening about sundown I heard the herald (as is the custom of this people) announcing something from the top of the pueblo. Upon inquiry, I learned that there would be a rabbit-

hunt in four days. Three evenings later, seated upon the top of the pueblo, as was our wont to do, while watching the gorgeous sunsets, we noticed that, in addition to the accustomed scene of home-returning flocks and herds, there were many herds of Indian ponies brought in and put into the *corrals*. This foretold a good turnout for the morrow. Just at nightfall the herald again proclaimed the hunt. At noon the next day the scene in the pueblo was an active one. Everywhere ponies and horses were being saddled for the chase. Some few who had no ponies started ahead on foot. Half an hour later we all gathered on the farther side of the river, on the road to Ojo Caliente, and a picturesque crowd it was indeed—between three hundred and four hundred horsemen dressed in calico of all colors and patterns, with all kinds of head-gear, from the *sombrero* decorated with eagle-feathers to the scarlet head-band. A few had bows and arrows, others had hoes and digging-irons; but all had two or more boomerangs, called *kle-a-ne*— simply curved sticks about eighteen inches long.* These they use to kill the rabbits, being thrown from the horse while in motion. A few Navajoes, who also took part, added to the scene. The hunting ground was about ten miles to the southwest, on the road to Ojo Caliente. It is generally customary to have a *ti-kwa-we* on the way down. So far as I could see, no betting was done, but the excitement at times was intense. There were four racers on a side, and the course was covered in very good time.

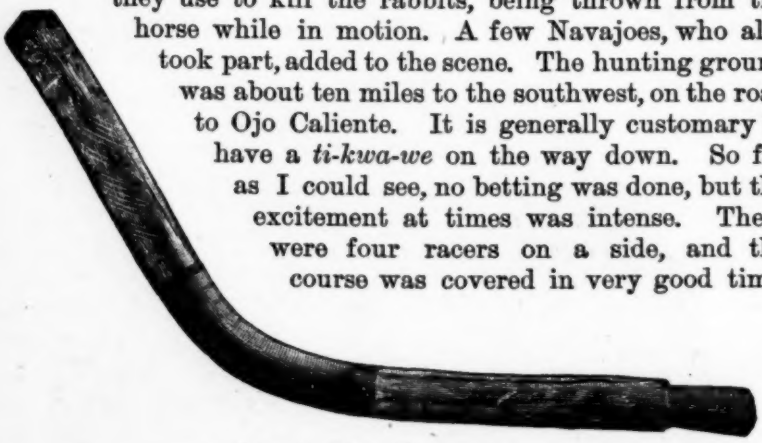

FIG. 4.—MOQUI BOOMERANG.

As the word was given to start, the company spread out over about an acre of ground, with the racers in the center. Each horseman cheered his side, and when the race was over I procured the *ti-kwa*. When we reached the ground, already the Cacique of the Sun had lighted a fire, and I was told he had put under it medicine to make the rabbits slow. This belief in the power to thus control wild animals is held by other peoples.

"This superstition is turned to account by hunters in many parts of the world for the purpose of running down game. Thus

* Fig. 4 represents a Moqui boomerang. Those used by the Zuñis on the rabbit-hunt were much the same, only not quite so well made, a stick with a less marked curve serving in most cases. They were thrown as clubs, with elbow forward.

a German huntsman will stick a nail taken from a coffin into the fresh spoor of the animal he is hunting, believing that this will prevent the quarry from leaving the hunting ground. Australian blacks put hot embers in the tracks of the animals they are pursuing. Hottentot hunters throw into the air a handful of sand taken from the footprints of the game, believing that will bring them down."*

The second priest of the Order of the Bow made a long speech, in which he told the hunters that the rabbits had been made slow, and they should get ready for the chase. After the ponies had rested a little, all mounted and set out. The more devout, however, before starting, went up near the fire, dismounted, untied their boomerangs, and got out a piece of bread. Advancing to the fire, they first said a prayer, then held their boomerangs in the flame or smoke a moment, and then threw a piece of bread into the fire as a sacrifice. Others dismounted and, without saying a prayer or offering any bread, just passed their boomerangs through the flame and remounted; while others only rode near the fire and, without dismounting, simply waved their sticks toward the flame and went on. The great majority, however, did not come near the fire at all. As I witnessed this feature of the hunt, I could not help silently observing that among the Indians there are degrees of devoutness as among white men.

The Priest of the Bow made a second and a third speech, and by this time the horsemen were well scattered over the plain. This was covered with sage-brush and scrub cedars. There are two species of rabbit, the cotton-tail (*ok-she-ko*) and the jack-rabbit (*pok-ya*). There was no attempt to surround a large territory and drive the rabbits; but, as one was started up, his pursuer would give a yell, and in a few moments the harmless cotton-tail or jack would be surrounded by fifty or sixty horsemen. As they close in on the rabbit, those nearest it throw their boomerangs, and whoever hits it is off in a moment to claim and pick up his game. If the rabbit is not already dead, it is at once dispatched by a blow with the hand, and then it is raised to the mouth, and the hunter inhales, believing he is taking in the spirit of the rabbit. He then ties it to his saddle, and is ready for another chase. The cotton-tail often takes refuge in a hole, and then there is a grand rush to the place to reach in and pull it out. Grubbing-hoes, digging-irons, and fingers are all used to enlarge the hole, and at last the poor rabbit is pulled out, with perhaps only half his hide on. Thus it was, for three or four hours, just a succession of rallies and deploys. At the end of that time nearly every one had one or two rabbits. Those on foot seemed to fare as well as those on horseback. I am told that

* J. G. Frazer, in Folk Lore, June, 1890.

sometimes they bring in wild cats and coyotes, caught in the same way, but they found none that afternoon.

About six o'clock a heavy shower came up, and the foresight of the Indian at once showed itself, for every one of them had his blanket with him, while I was thoroughly drenched. As we returned to the pueblo, many feats of horsemanship were displayed and a number of races run.

The rabbits are given by the hunters to the squaws, who place them on the floor of the house, with an ear of corn between their paws. Bandelier tells us that formerly these hunts were conducted in behalf of the caciques of the tribe, but this custom seems to have fallen into entire disuse.*

AN EXPERIMENT IN MORAL TRAINING.

By Dr. MARY V. LEE.

WHILE waiting in a corridor of the Oswego Normal School building, forty or fifty lads and lasses from the practice school marched in quadruple column past me. They were full of life, observant, unaccompanied by teacher, but attending to the duty of the moment in an orderly manner. The company separated, each division passing to its own room. After a brief interval I followed the band, made up of boys and girls from fourteen to sixteen years of age. I found them conversing with their principal in such manner as induced me to tarry. The experiences of that hour seem so full of meaning as to deserve record and emphasis.

Evidently the pupils were for the time unconscious that the gentleman before them was vested with authority; evidently it was his purpose to show no authority, but to talk with the children as heart to heart, as man to man. Freedom, earnestness, and sincerity characterized the interview; in fact, the spirit of the room constantly suggested, "Come, let us reason together."

Below I give a free reproduction of that which I saw and heard:

Teacher. Several weeks ago I left a question for you to think about. What was it? (Each pupil raised his hand thoughtfully, and the teacher indicated who might respond.)

Pupil. You asked how many of us were willing to have those pupils who hinder the work of the class removed from it.

Teacher. Yes. How many have decided? (Each of the nineteen pupils raised the hand.) How have you decided, Henry?

* Ad. Bandelier, Papers of the Archæological Institute of America. American Series, iii, p. 160.

Henry. I am willing.

Teacher. How many are willing? (All but the largest lad signified their willingness.) Why are you not willing, John?

John. I do not think the boys have had a fair chance. (I then became aware that two boys belonging to the class were absent. During the remainder of the lesson these boys, whom we will call Frank and Ward, were frequently referred to by name.)

Teacher. What do you mean? You know I have spoken to them repeatedly. They know they hinder the progress of the class by their conduct. How have they not had a chance?

John. I don't believe any of *us* have talked with Frank and Ward.

Teacher. How many have spoken to them about their conduct? (Not one hand raised.) How many have done anything to signify disapproval of it? (One of the older girls, with serious and even anxious expression, raised her hand.) What have you to say, Mary?

Mary. I have not *spoken* to the boys, but the other day when Ward was doing wrong I shook my finger at him like this.

Fanny. I have not spoken, but I have shaken my head at Frank.

Teacher. Two out of nineteen have expressed disapproval of conduct which interrupts the work of our class. I am glad two have tried to help by the warning hand and the warning head. It is a question of the removal of Frank and Ward from this class, where they hinder, to a room where they may learn to be helpers—may learn by more severe measures than we use here to control themselves. Only one in this class has been sent to that room; he may tell us if being placed in it helped him. (The lad referred to rose and stated frankly that he had been helped by being in the room named.)

Teacher. For whose good would Frank and Ward be put in that room?

Pupils. Theirs and ours.

Teacher. Yes. Then why not vote to place them there?

John. I think the class ought to try to persuade them to do better before they are sent away.

Teacher. So do I. I saw a policeman step up to a disorderly man on the street, put his hand on his shoulder, and quietly say: "You better go on, better go home; if I find you doing this again, I shall have to gather you in." The policeman was giving friendly warning to the man. How many of you are willing to warn Frank and Ward? How many are willing to talk to them about their wrong-doing? (All hands but John's raised.)

Teacher. How is this, John? You are not willing to have the boys taken from the class, and you are not willing to talk to them.

John. You see, Mr. Norton, I am just as bad as they are, and I couldn't speak to them. (Said with much blushing and great openness.)

Teacher. In my school in —— were two boys. No, I must not say *my* school, I must say *our* school, for there we had got on so far that the pupils used to say *our* school. Well, in our school in —— were two boys, Ned and Tom. After Ned had been in the school a year and had grown to be a reliable lad, a great help to us all, the school board in —— voted to take Tom from the school he had been attending and to put him in our school. Tom's father came to see me, and I asked him to tell me about his son. This is what that father—he was a lawyer and a judge—said: "Mr. Norton, if my boy can have a bull-dog that will chew up every dog in this town; if he can own a game-cock that will knock over every game-cock in the city; if he can have a horse that will throw dust in the eyes of every other horse in town, he is happy. But, Mr. Norton, that boy has not a single literary aspiration." I was not particularly anxious to have in our school a boy of whom his own father—and he a judge—gave such an account, but he came without a personal invitation from me. For two days he behaved himself, but the third day he was at his old tricks. Why did he behave himself at first?

Pupils. He didn't know how the new pupils would take him. He was just waiting to see what stuff they were made of.

Teacher. Exactly. He introduced his accomplishments gradually. What do you think his classmates ought to have done when he began to perform?

Pupil. Not look at him.

Teacher. Good. If when he had stood on his head in one corner—I do not mean to say that was his particular *forte*—and had looked up for admiring approval, he had found all the class attending to school-work, if he had then turned his best somersault, but still could catch no eye wandering from the real business of the hour, what do you think he would have done?

Pupils. Stopped his nonsense.

Teacher. Yes, I think so. But those pupils *did* look at Tom occasionally with a certain degree of admiring interest; they had not grown altogether self-controlled. What would be the effect of this attention from the class?

Pupils. Tom would cut up more and more.

Teacher. He did. One day Ned, in a talk with me, said that he and Tom used to be great friends, that they used to make it very interesting for their teachers in the other school; what one could not think of the two could. I asked Ned how it was he had changed, had stopped making it so interesting for the teacher, and had become reliable and attentive to school business. He said:

"Mr. Norton, the boys did it. When I cut up they talked to me, and they kept on talking till I just had to quit my old ways." Then I said to Ned, "Who is going to talk to Tom?" He replied quick as a flash, "Mr. Norton, I never could, for you see Tom and I used to be in the same boat, and if I should talk to Tom he would laugh at me good." I did not ask him to speak to his friend, but I did ask him who would do it and help get him on the up-grade. To make the story short, the outcome was that Ned volunteered to talk to Tom. Tom turned round, and in a year that Tom who had not, according to his own father's statement, a single literary aspiration, elected to enter the academy and go on with his education. Ned did a good work for Tom. Tom was the hardest boy I ever knew who turned right about and set his face toward the top of the hill. I have known worse boys whose faces were always toward the foot of the hill.

(During the preceding narrative the class was an engaging sight. Their faces, grave at first, broadened. The little chap who had got good in "*that room*" expanded till he covered all that part of his desk separating him from Mr. Norton; he put his head on his outspread arms and opened every avenue to the reception of information regarding the boys who made it *very interesting* for their teachers. Suppressed chuckles showed his admiration for Mr. Norton's word-pictures of boys. Even Mary smiled protestingly. In Ned's relation to Tom, John saw his to Ward and Frank; the sense of his obligation to them grew stronger, and finally he screwed his courage up to volunteering to promise to do his duty and talk to them when they disturbed the class.)

Teacher. I know it is not always easy to speak to a friend who is doing wrong. One has to deny one's self for others. I visited a home a while ago in which were father, mother, three sons, and two daughters. There was a small salary and a little farm. The boys were to be sent to college—two were there. All the nicest fruit on the farm, the best vegetables, the cream were sold, and the family lived on the plainest food, that the boys might be educated. The father wore old clothes except when he preached. The mother had no nice dresses, she worked hard, her hands were not pretty, and her face was full of wrinkles. The father and mother were always denying themselves every luxury and many comforts for their children. Do you suppose they gained anything because they denied themselves?

Pupils. They grew good. They grew generous. They would have their reward.

Teacher. Yes, patience, fortitude, love, goodness showed in the faces of that father and mother. A reward comes to any one who denies himself through love of another; he is not just the same after the denial; he is better and stronger.

At this point I was called from the room, but I learned that each member of the class promised to do his duty by Ward and Frank if they remained in the class. I learned that these boys were told by Mr. Norton that their class voted to retain them. The boys promised to try to do their duty. Mr. Norton told them that boys reported that they had a good time when they talked with him in his office. He was glad they had a good time, he also enjoyed it; but now that they had given their word of honor to try to do their duty, he thought he ought to have evidence that there had been more than a good time. "What shall we do, Mr. Norton?" "Anything you like." The boys conferred, then wrote and signed a promise, which they gave their principal and *asked* him to read to their mates that they might know that they were in earnest. After this they were returned to their room, which is in charge of an apprentice or practice teacher.

A few days after I visited the class and found Frank and Ward doing well. Later they relapsed somewhat. During this relapse I met Mr. Norton and reported it to him. He smiled hopefully and said: "Young persons do not move steadily toward the desired haven; they drift, adverse winds sweep over them; in fact, their progress is very similar to that of adults. I do not ask how far on the way my pupils are, but which way they are tending. Frank and Ward are tending toward the haven. I will see them, ask them how they are doing, encourage where I can, remind them of their promissory note in my pocket, warn them if I must. We are on the up-grade. Character-building is a slow process; have you not found it so in your own case?" "Yes," was my reply. "But, Mr. Norton, why do children so hate to go into *that* room, so hate to vote to have their mates go there when they frankly say it is for the good of the pupils who go, and for the class relieved for a time of their presence?"

"Because they are coming to appreciate character, to admire the person who can govern himself. They see a difference between the men in prison who do not use whisky because they can not get it, and the men outside who do not use it because they *will* not. They are feeling the dignity of freedom and the responsibility that accompanies it. They look upon their class-room as a place where the pupil is free—free to do his own choosing. When he shows by persistent wrong-doing that he can not be trusted to choose, he goes to 'that room' where another chooses for him and enforces his choice, if need be, by the use of the rod. The more strength for right choice the pupils get, the more reluctant they are to vote their mates destitute of power or determination to choose wisely, which they do when they banish them to that room."

I believe lessons like the one recorded are unusual. The points which seem to deserve emphasis are—the freedom and sincerity of the pupils, their entire lack of antagonism to such discussion, their clear perception of the facts in the case and of the relations of cause and effect, their acknowledgment of their duty and their resolve to do it. While there was reference to the conduct of Ward and Frank, the discussion mainly related to their own duties and responsibilities.

Being acquainted with the average youth of the age of these pupils, I saw that the conversation I had heard was the latest of many. The freedom, the seriousness, the consideration for others, and the final decision to help, indicated that this class had passed beyond the primary grade in morals.

Another thing was impressive: These pupils were helped to a correct emotion regarding duty, but the matter did not end in emotion; they were immediately and purposely so circumstanced as to have continual opportunity to decide in accord with their ideals of right or to decide against it. Further, it was evidently Mr. Norton's plan to show the pupil his own good purpose whenever he seriously failed to execute it, and to inspire him again with hope and decision.

Is not this class in the practice department of the Oswego Normal School getting moral *training*, not simply moral instruction? Might we not indulge in cheering visions of the citizens our schools might rear were all our children getting similar training? Give us a century of such work in our schools, and such an article as that on Education and Crime, in the Monthly, would be a curiosity

NOTE.—To-day, November 21st, nearly a month after the preceding was written, the practice teacher in charge of the class before considered reports that Frank is daily improving, but that Ward is still an annoying lad. "But," said she, "a glorious thing happened to-day. The pupils were hard at work, with the exception of Ward, who was very troublesome, when Frank gave him a stern rebuke and then returned to his lesson. So you see Frank is growing in self-control and in desire to help in our little community."

IN the old silver mines of Pribram, in Bohemia, there are several vertical shafts exceeding 900 metres in depth. The shaft Saint Prokop is 909 metres; Saint Anne, 942 metres; Francis Joseph, 992 metres; Saint Adelbert, 1,099 metres; and Holy Virgin, 1,116 metres deep. Subterranean observatories have been established in the thirty-second stories of the two deepest shafts, for the notation of variations of temperature and magnetic deviations. The rocks of central Bohemia belong to the Silurian system, and these two shafts are certainly the deepest vertical shafts in hard rock in existence. Besides silver and other precious metals, more than eighty species of minerals, some of them very rare, have been found here. This makes Pribram one of the most remarkable mineralogical locations on the globe.

PROFESSOR HUXLEY ON THE WAR-PATH.

By the DUKE OF ARGYLL.

II.

[*Concluded.*]

BUT now—if Nature has indeed never stopped her operations at any one time—if they have been, on the contrary, always continuous in unity of plan amid every change in method, then it follows that we do not know how often new germs may have been introduced and may have had their full development accelerated by processes of comparatively short duration. Darwin, in a passage but little noted, has thought of this. He speaks of stages of development being possibly "hurried through."* We see this actually done in the living world, although we do not often think of it as we ought. It is done in all the mysterious phenomena of metamorphosis. A comparatively low and simple organism goes to sleep, and in a few weeks—or a few days, or even, it may be, in a few hours—it awakes entirely reformed, reconstructed, provided with new organs, and fitted for absolutely new spheres of activity and life. We do not know whether this method of creation may not have been repeated over and over again with abiogenic germs—just as it is now repeated in an infinite variety of forms among the germs which are biogenic. I am contending now for a true and honest agnosticism and not for any theory. We do not know that inheritance by descent is the only possible or the only actual cause of likeness and homologies in organic structure. It is not the cause of it as regards the inorganic world, and it may not be the only cause of it in those houses which have been made out of inorganic materials to be the abodes of life. It is indeed not possible that inheritance can be the only cause of likeness—if it be granted that the first starting-point of development must have been in germs which had no organic parent. On the other hand, we can be quite certain of the reason why organs should be made like each other, although we can not be sure of the physical causes through which exclusively this likeness must be brought about. The reason is that certain needs must be met by appropriate apparatuses—vital, chemical, and mechanical. Extraneous matter must be assimilated, weight must be supported, circulating fluids must be supplied with oxygen, light must be caught upon adapted surfaces, and must be transmitted through focused lenses, if sight is to be enjoyed. And so on. The Why is within our knowledge. The How is most doubtful and most obscure. Geology, above all other sciences,

* Origin of Species, sixth edition, p. 149.

impresses this ignorance upon us—even as regards some of the simplest of her operations. Sometimes it is difficult to understand the conditions of original deposit. Very often it is still more difficult to understand the conditions of denudation or removal. The great earth-movements which have certainly taken place are full of mystery—the depressions and elevations, the cracks and "faults" which have dislocated the strata, the "downthrows," sometimes of thousands of feet, which have cut across the rocks as sharply as if the cutting had been effected by a knife, the overthrows and the overthrusts, the sinkings and the underthrusts, which have inverted the order of original formation, the metamorphism which has obliterated original structure here, and has left it wholly unaltered there; the vast thicknesses which are destitute of the remains of life, in juxtaposition perhaps with some one thin bed which is crowded with them; the methods by which, and the times during which, old forms of life have been destroyed, and new forms have been introduced—all these, and a thousand others, are questions on which our ignorance is profound.

Now, it is a remarkable fact that all these difficulties are, as it were, multiplied and accentuated in that very period which is nearest to us—that period which was marked by the very latest changes of which geology has any cognizance—I refer to the period which is now generally called Quaternary. It is sharply marked off from previous periods by a strictly scientific definition. Shells, and particularly marine shells, may be called the time-medals of creation. Their comparative indestructibility, and the fact that the element in which their inmates live is the same element which preserves their habitations when they die, make it certain that in them Geology keeps her oldest, most complete, and most authentic record. The Quaternary period is defined as that during which innovation was stopped as regards the development of shell-life—during which no new species was born—during which we find, with a few rare exceptions, no shell which is not also an existing and a living species. As regards them, therefore, the Quaternary period is the existing period in the classifications of geology. It is the age in which we ourselves are now living. And yet this is the very period during which the greatest novelty of all seems to have been introduced, for it is in this period that we can first detect the advent of man. Moreover, it is in this period that there seem to have been some of the most mysterious earth-movements of which the science has any glimpse. Great dislocations of strata—great changes in the distribution of land and sea—great destruction of preceding forms of life, are among the familiar conceptions which its best-ascertained phenomena suggest. Nor is this all. The vanishing of preceding forms of life in many older periods

may have been gradual, and the creatures which disappeared may be supposed to have lived on in their modified descendants. But in our own Quaternary period multitudes of the vanishing beasts seem to have been destroyed by some great destruction, many of them leaving no descendants whatever to represent their antique and abandoned forms. Nature has simply obliterated them altogether. All these circumstances, and many more, combine to make this present geological period in which we are still living—the Quaternary period—one of the darkest and most mysterious of all. Thus every possible question which is the most difficult in geology seems crowded and aggregated into the age which stands nearest to us, and to which geologically we ourselves belong.

If, then, there is any one of the halls of science into which we should enter with uncovered heads, it is surely that in which the grand problems of Quaternary geology are handled and discussed. If in her great temple there be any pavement on which a true and wise agnosticism would tread with cautious and humble steps, it is upon that which constitutes the threshold of inquiries so complicated as to facts, so difficult as regards the interpretation of them, and so profound in their bearing upon other subjects of the very highest interest and importance. Yet this is the threshold across which Prof. Huxley comes tripping on the light fantastic toe. It would be hard to say whether his utterances are most conspicuous for their dogmatism or for their levity. All agnosticism is forgotten, and all sense of ignorance is denied or silenced. After pouring out the vials of his wrath and expending the arrows of his ridicule on a conception of the Deluge which nobody entertains, he turns fiercely on a German author who has ventured to suggest that some catastrophe greater than any mere floods of the Euphrates and of the Tigris may possibly have happened among the many and obscure changes recorded in Quaternary geology. Prof. Huxley seems very anxious to get this idea out of his way. He won't hear of it. He knows all about it, at least for the purposes of denial. He does not argue the question. He does not give any reasons. He simply denies the possibility as of his own authority, and pronounces it to be "particularly absurd." This attempt to settle by an *ipse dixit* what can and what can not possibly have happened during the great physical changes of the Quaternary age, will never do. Even if it were only on account of our utter ignorance of all details respecting those changes, that ignorance is notorious enough to condemn such an attempt as an offense against all the legitimate methods of science.

But there is worse than this in the sentences which follow. Prof. Huxley declares contemptuously that the occurrence of any catastrophe during the Quaternary age, such as could give rise to

the traditions of a deluge, is an "hypothesis which involves only the trifle of a physical revolution of which geology knows nothing." Now here we have a positive assertion; and it is one which can only be met by a contradiction as direct and flat as truth demands, and as the courtesies of literature will allow. Once upon a time in discussion with an illustrious and venerable man, Prof. Huxley felt called upon to say that his opponents' assertions were "demonstrably contrary to fact."* I may safely assume, therefore, that this is a form recognized by the highest authority as occasionally required even in the calm and lofty debates of science. This, accordingly, is the form of contradiction which I now venture to adopt in meeting the confident assertion of Prof. Huxley. I do so, however, declaring emphatically that I have no suspicion whatever that Prof. Huxley intended to deceive anybody, whether himself or others. All that I am sure of is that if others believe what he says on this matter they will be deceived, and deceived grossly. The explanation lies in the fact that, in the hot pursuit of his theological antipathies, he has made the very simple and natural mistake of confounding "geology" with himself. But these two are not identical or convertible terms. He may not have seen—because prejudice has shut his eyes—some things which geology has seen, and seen very clearly too. He may not know of, or recognize the full import of, facts which geology does know of, and has established. But whether he knows of them or not—whether he has ever "put two and two together" in respect to them—it does so happen that among the difficult problems of Quaternary geology, three great salient conclusions have been established. The first is, that among the very last and latest changes in the history of the globe there was a great extension to the south of the conditions of climate which are known as glacial. The second is, that during part of that time—and almost certainly during the very last part of it—or even since it ended—there was, over some great part at least of the northern hemisphere, a great submergence of the land under the waters of the sea.† The third is that man had already appeared upon the earth, and had more or less spread upon it, before that late submergence took place, and must, therefore, have been a witness, and may possibly have been a victim, to it. Now, the first two of these conclusions are not only "known to geology," but are among its most widely accepted doctrines, while the third has made great progress and is rapidly taking—if, indeed, it has not already taken—the same place and rank in the category of discovered and admitted truths.

If, then, these three great facts have acquired this position—and even if they be disputed by a few writers, or by Prof. Huxley

* Comparative Anatomy, p. 98. † Text-Book of Geology, by A. Geikie, p. 891.

himself—it is "demonstrably contrary to fact" to allege that geology "knows nothing" of them. The science knows of them so well and so familiarly that "the last great depression" has become a stock phrase among Quaternary geologists—as referring to many ascertained phenomena which are capable of no other interpretation.

It may, however, be well asked how it is, if these three great facts have been established, that the conclusions flowing from them have not been followed up. The explanation is as easy as it is instructive. It has been due to that one cause which, perhaps more than any other, has impeded the advance of science—the blinding effect of invincible preconceptions. Sometimes these have been aggravated by such intellectual aversions as that which animates Prof. Huxley against everything connected with Christian theology. But many desperate preconceptions have other sources. The authority of great men who have fallen into some great error has been one of the barriers most difficult to breach. Of this kind perhaps the most memorable example was the power of Sir Isaac Newton to postpone for nearly a century and a half the establishment of the undulatory theory of light. The furious and contemptuous attacks made upon Dr. Thomas Young, when in our own day he revived that theory and poured the light of his own genius upon it, remind one very much of the temper and the spirit in which some men are now meeting those movements of discovery that tend to reopen questions which only ignorance had closed, and to give to old ideas a new and scientific basis. Then there has been another source of abounding prejudice. The shape in which those old ideas were at first presented has often been really deforming and erroneous. This has been pre-eminently the case with the form under which the idea of a deluge has come across the pathway of geology. At first men would not believe in the reality of fossil shells. When this reality was proved to demonstration, then the supposition was entertained that they were carried into the solid rocks by the Noachian Deluge. The absurdity of this supposition was almost sickening, and it established a lasting sense of nausea in all the stomachs of geologists at the very mention of a deluge as coming at all within the cognizance of their science. This is just the attitude of mind which sets up the most insuperable preconceptions, and renders men insensible to the force of any evidence which even seems to look in the direction of their disgust. In this very article Prof. Huxley makes a confession upon this subject, which he does not mean as such, but which, nevertheless, is a confession most true and most significant. "At the present time," he says, "it is difficult to persuade serious scientific inquirers to occupy themselves in any way with the Noachian Deluge. They look at you with a

smile and a shrug," etc. This is quite true. But it is also true that the attitude of mind thus depicted is most unsafe and most unphilosophical. I confess to having myself lain under the incubus of the same preconceptions for many years. It was of course easy to take refuge in the bolt-hole dug out by Lyell—that if there ever was a deluge it must have been an event so "preternatural" in all its circumstances and effects that there is no use in even thinking of it in connection with any of the physical sciences. Yet the promptings of our intellectual conscience will perforce suggest that, though belief and reason are not coincident in extent, they ought to be coincident in direction, and that physical events of great magnitude, if they happened at all, however preternatural, were presumably brought about by physical agencies which must have left some effects behind them, unless subsequent obliteration has destroyed the evidence. This last alternative was indeed easily conceivable in the abstract. It is, however, always less easily conceivable in each actual case in proportion to the magnitude of the supposed events and the recency of their supposed occurrence. But this method of looking at the whole case, which is purely logical and scientific—this perception of alternatives turning upon evidence, and on the possible causes of the want of any evidence at all—is a method which at once awakens our intelligence to the testimony of facts, and breaks down the stupid preconceptions which blind us to the true interpretation of them. It puts an end to that irrational attitude of the mind which Prof. Huxley, strange to say, seems to approve of and applaud, in which we can hardly be persuaded "to occupy ourselves in any way" with a great problem, and in which we can only look at it "with a smile and a shrug."

Once roused from this paralysis of our reason, we soon find that there are abundant materials on which to exercise its powers. I live in a district of country over the whole of which the evidence of "the great submergence" is as striking as it is ubiquitous. I estimate the depth of it as having been at least two thousand feet. Not less decisive is the evidence that it must have happened among the very latest operations which have been at work upon the globe. Charles Darwin saw this in 1839, when he came to the West Highlands to look at the famous Parallel Roads of Glen Roy. His estimate of the minimum depth of it was at least 1,280 feet. He saw it, and he dwelt upon it with emphasis in the celebrated paper in which he recorded his observations. No one who resides in the low country where the rocks are never seen except in quarries, can have any conception how clear and unmistakable are the proofs of some temporary, and very recent, depression of our land, with almost all its mountains, under the level of the sea. Then comes corroboration after corroboration from every field of

Quaternary geology. For thirty years and more geologists have known, and have been staring helplessly on the fact, that in North Wales one of the hills of the Snowdon range is covered with a marine gravel at a level of 1,130 feet above that of the present sea. They have known the fact that this gravel contains shells in abundance, all of existing species. They have known it, but most of them have been reluctant to "occupy themselves about it in any way." Even in recording it they generally leave it, if not "with a smile and a shrug," at least with a timid and embarrassed glance. Yet nothing in the whole range of their science is more mysterious and instructive than that Moel Trefan top. Old Ocean has been there, and he has been there very lately. He has been there as regards the area and the locality, and he has been there in a passing way, but he has not necessarily been there as regards its existing level. Prof. Huxley tells us that a heaping of the sea over a particular place is a physical impossibility. I quite agree. Then it follows that Moel Trefan must have been sunk under the sea and raised out of it again, all within our existing age. Can the learned professor tell us how wide has been the area of depression in which Moel Trefan was included? Was it contemporaneous or not with a like submergence all over the Highlands of Scotland? And if so, where did it stop? Prof. Prestwich has said that it prevailed over the whole of Ireland, over the whole of Wales, over all the center and north of England, and over the whole of Scotland.* A large part of Russia, and all northern Germany down to Holland, were also included.† And is he certain that it was not wider still, and included larger areas of the whole northern hemisphere? Quaternary geology certainly suggests, even if it does not establish, that it did. Italian geologists of the highest authority report the same facts from Calabria and from Sicily. Gravels with three hundred kinds of existing shells are piled up at elevations 2,400 feet above the Mediterranean. Was Charles Darwin an ignoramus in geology when he recognized exactly the same phenomena on the vast continent of South America? The facts he records respecting the massive marine gravels of Patagonia, the recency of them, and the correlative destruction of the great mammalia, are more astonishing even than the parallel facts in Europe.‡ Are the geologists of Canada deceived when they report similar facts as establishing similar conclusions over the greater part of northern America? If the submergence was local, but the locality was as large at least as the British Islands, how "particularly absurd" is the assumed impossibility of a partial deluge! If it was far wider, then how

* Proceedings of the Royal Society, No. 196, 1879.

† Quarterly Journal of the Geological Society, August, 1887.

‡ Naturalist's Voyage, edition of 1852, pp. 170–176.

absurd also is the denial that it may have been as wide as the whole area occupied by man at some early stage of his dispersion! Further, can he tell us whether this "great submergence" over more than one great area, was balanced or not by any corresponding elevation over some other? And if it was, then can he tell us whether the elevation may not possibly have been a raising of some ocean floor? And if it was, can he assure us that the "fountains of the great deep" did not perforce pour their waters over corresponding areas of the land? Can he tell us how deep the great submergence was, as well as how wide? Above all, can he tell us how slow it was, or how rapid? If he can't tell us any one of these things, or make even a plausible attempt to do so, then he has no right to tell the world that Quaternary geology "knows nothing" of any more adequate basis for the world-wide tradition of a deluge than a flood in Mesopotamia. Quaternary geology is still in great confusion, the prey of extreme theorists, and of many baseless hypotheses. But it is not quite in such a mess as Prof. Huxley would represent it to be. For one thing, it has established "the great submergence" with all its consequences.

But this is not all. When once the scales of preconception and of spurious authority have fallen from our eyes, they are opened to other facts which have been as clearly ascertained, as timidly regarded, and as feebly interpreted. In particular we see the fleshly bodies, and the complete skeletons, and the collected and compacted bones of millions of great animals which have perished—very lately—many without leaving descendants—and have so perished as to be preserved in superficial deposits scattered over many portions of the globe. In my own case, it was the futility of the explanation given of these facts of Quaternary geology by the Lyellian school that first awoke my attention, now many years ago, to the untrustworthiness of the method in which these facts were handled. Nothing that savored of the possibility of "catastrophes" would that school even look at fairly in the face. No idea that would not fit, or could not be squeezed, into their own narrow interpretations of the doctrine of uniformity, could find entrance into minds swathed in the bandages of the great hurdy-gurdy theory. I can not in these pages give, even in abstract, the astonishing facts which Quaternary geology has established respecting the death and preservation of what are called the Pliocene and the Pleistocene mammalia—and this, too, both in the Old and in the New World. They have lately been collected and marshaled with exhaustive research, and with admirable ability, by Mr. Howorth, M. P., in his book on The Mammoth and the Flood. I observe that a most significant silence has been maintained respecting this array of facts and arguments, and that the

old-school geologists have found it much more convenient to ignore than to answer it.

Then, lastly, the same observations apply to the abundant evidence which Quaternary geology has supplied that man was living before the mammoth and its compeers were all destroyed. The spirited outline of a living mammoth has been left to us by some incipient Landseer of a not very ancient world. The consequences which are involved in this fact were long evaded—never faced or followed—just as the consequences were long evaded of marine gravels heaped upon the tops or the high flanks of our existing mountains. When palæolithic implements were first discovered, not many years ago, both the religious and the agnostic world were fluttered and excited. The one hoped for, and the other feared, the establishment of some hitherto undreamed-of antiquity for man. Both of them forgot that those old implements have, intellectually as well as physically, a double edge. They may serve to establish the extreme recency of some great convulsion—far more than they tend to prove the extreme antiquity of the creatures affected by it. With an instinctive dread of this alternative, vigorous attempts have been made to treat all implement-bearing gravels as fluviatile—the work of existing rivers and the spoil of existing water-sheds. It has been felt that indefinite drafts might then be drawn upon the bank of time—because the implement-bearing gravels are often at high levels, and existing rivers must have been at work for some indefinite number of ages to cut their way down to the present lower channels. But again these attempts have broken down. Human implements—it is confessed—have now been found abundantly in gravels which must have been at least spread and redistributed not by rivers, but by the sea.* Moreover, it is admitted that the old implement-bearing gravels often exhibit the marks of "tumultuous action." Thus all along the line Quaternary geology has established not only the possibility, but the certainty, of many of those events which Prof. Huxley presumes to denounce as "particularly absurd." Every year is opening up some new vista through the thick clouds which envelop the Quaternary ages. Prof. Prestwich may almost be said to be the father of this geology in England. No one man has done so much for it; no one has been so minute and laborious in research, or so careful and conscientious in reasoning on its facts. The very last result he has arrived at† is the probable discovery of the lowest stratum, or the base bed, of the Quaternary series in England. And what is it? It is a thick bed of marine gravel overlying an old terrestrial surface on which now extinct mam-

* The Great Ice Age, by James Geikie, pp. 505, 506.

† Quarterly Journal of the Geological Society, February, 1890, p. 85.

malia lived, and fed, and were destroyed. This gravel stretches up the valley of the Thames, till it reaches elevations eight hundred and fifty feet above the level of the sea.* It contains pebbles, washed, rolled, and translated all the way from the rocks of the Ardennes. This alone records a depression of the land great enough to swamp, not only the greater part of Europe, but the greater part of the habitations of man all over the globe. Prof. Prestwich expressly connects these gravels with great changes in physical geography, and with the destruction of the older or "Pliocene mammalia."

It is impossible in these pages to treat this subject in detail. I have dealt with it at all—and of necessity in the merest outline—only because the confident assertions of a man so eminent as Prof. Huxley are apt to intimidate young inquirers, and to keep up in their minds the fatal preconceptions of spurious authority. But they should remember that though Prof. Huxley is a distinguished expert in biology in all its branches, including paleontology, he enjoys no similar authority in dynamical or stratigraphical geology. *Ne sutor ultra crepidam.* Still less can he, or indeed any other man, be allowed to browbeat our reason in coming to those conclusions which men of even ordinary understanding are perfectly competent to draw from facts which others have ascertained.

There are many miscellaneous things in Prof. Huxley's article on which I have no space to comment. It reminds me of a witty description once given of a favorite but somewhat barbaric Scotch dish—the boiled head of a sheep—"There's a lot of fine confused feeding upon't." A few of these miscellaneous morsels may be tasted in the mean time. Prof. Huxley makes a very lofty claim for Science. It belongs to her, he tells us, to deal with the problem "of the origin of the present state of the heavens and the earth," and also that of "the origin of man among living things." "The present state" are limiting words which make the claim somewhat ambiguous. "The present state" of the earth certainly belongs to history, and much of it to very recent history indeed; and so with regard to the origin of man, if it be equally limited to his "present state." The present state of the members of the Royal Society would be an inquiry not necessarily leading us very far into the past. But if the "origin of their species among living beings" be intended, then science has hitherto offered no suggestion, except that they are all descendants from "some arboreal creature with pointed ears." Science has a good deal to do yet if the task assigned to her by Prof. Huxley is ever to be completed. Another boast goes very near to the assertion that to sci-

* Quarterly Journal of the Geological Society, May, 1890, p. 140.

ence belongs the power of deciding whether there are any agencies in the spiritual, which can produce effects upon the material, world. I suppose we shall be told presently that science can decide, by the microscope and the dissecting needle, whether the Sadducee was right in denying either angel or spirit, and the Pharisee was a fool in confessing both. Our agnostic professor may well be happy in the prospect of such unbounded knowledge being obtained by such simple means.

Then we have a very lofty boast about the hopeless position of Christian divines "raked by the fatal weapons of precision with which the *enfants perdus* of the advancing forces of science are armed." We are tempted to ask if Prof. Huxley himself is one of these "enfants." If so, he must have laid down his arms before he fired off this article. Anything less like a weapon of precision than that which he has shouldered in the fight, it is impossible to conceive. "Old Brown Bess"—with its clumsy bullet, its devious flight, its low penetration, and its enormous windage—is indeed almost a weapon of precision in comparison with that which Prof. Huxley here flourishes against the massive foundations of Christian belief. But, perhaps, he means rather the small arms of the modern critical school. If he does, then precision is the very last characteristic which belongs to it. Its methods are largely subjective. Here and there it may have a clearly ascertained fact to rest upon. Here and there it may have arrived at some tolerably secure results. But in the main its methods are metaphysical, resting on nothing but individual preconceptions, applying tests and private canons of interpretation which are purely arbitrary. There is no credulity like that which leads the agnostic to swallow with open mouth everything that issues from that most copious fountain of fads and follies—the inner consciousness of a German professor.

The assumption which inspires the tone of Prof. Huxley's language on this subject—that precision in research is undermining the credit of the Hebrew Scriptures—is an assumption almost comically at variance with fact. There is, in particular, one weapon of precision which has been of late working wonders in precisely the opposite direction. That weapon is the spade. And what has it been unearthing? Everywhere over that narrow strip of our planet on which its human interests have been most impressive and profound—everywhere from Tyre and Sidon—from Carmel and Lebanon—on the west, to Babylon and Nineveh and the boundary mountains of Assyria, on the east—the spade has been disentombing continuous and triumphant proof of the genuine antiquity and historical character of the Jewish books. Out of them comes the light which guides the explorer; and out of them shines the light which is reflected from his spoils. They

give the true and only key to the earliest partings of our race. They are true to the rise and progress of divided nations. The picture of manners which they present is not less faithful than the account they give of early habits and pursuits both in peace and war. Only the other day Mr. Flinders Petrie* has told us how the spade has uncovered those impregnable walls of the Amorite cities which were reported to invading Israel by the spies of Moses. They are found to be more than twenty-eight feet thick at the base—fit to support a superstructure of at least fifty feet in height. There will come, I suppose, our wonderful agnostic critic to point out that the record in Deuteronomy says that these cities were "walled up to heaven."† But these walls of Lachish could never have reached the Pleiades. They could not have so much as touched the moon. Nay, it is certain that they could not have approached even the limits of our own atmosphere. Therefore the book of Deuteronomy is unhistorical, and Christian theology is founded on the "quicksands of fable"!

But the spade, as a true weapon of precision, has done more for us than this. It has revealed to our living sight, in the remains of Nineveh and of Babylon, all the mysterious imagery of the prophets, and all the literal historic truth of their tremendous denunciations. It has revealed in numberless inscriptions‡ the shameless confession of that inordinate pride and cruelty which dictated the policy, and the desolating deeds, of the great military monarchies of the East. It has explained their fall and their own subsequent retributive desolation as foreseen in the magnificent visions of Nahum and Zephaniah, of Ezekiel and Isaiah. Such hideous wickedness could not be allowed to last. Their doom indeed was written in the moral law; and one of these prophets expressly founds his predictions on his confidence in that law as the will of the "just Lord." "Every morning doth He bring his judgment to light; he faileth not."§ But when the chariots of Assyria were still issuing from the gates of Nineveh—"the bloody city"—it required a prophet's eye to read the sentence. When Nebuchadnezzar, or his latest successor, was still lounging in his palace richly colored and shining with enameled walls—when the hanging gardens of Babylon were still in bloom—it required some open vision to foresee the time when they should exist no more—when for centuries the very site of them should be uncertain—and when the mounds of their ruin should be given over to the owls and to the bats.

Then there is a higher sphere of prophecy into which we rise

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* In connection with the Palestine Exploration Fund. † Deuteronomy, i, 28.

‡ Assyrian Discoveries, by George Smith, pp. 256–282, and *passim*.

§ Zephaniah, iii, 5.

upon steps more solid even than the buried slabs of Nineveh. There are some splendid and powerful words in one of the books of the New Testament which indicate the true value to be set upon the demonstrable facts of Hebrew prophecy—first, as a support to our faltering, or to our faint, beliefs, and then as a guide to still deeper spiritual insight. I speak of the call which bids us "take heed" to "the more sure word of prophecy, as unto a light that shineth in a dark place, until the day dawn, and the day star arise in our hearts."* They point especially to those Messianic visions in which some Jews, speaking to other Jews, yet burst through all the barriers of their intense exclusiveness, and tell them to look to a Deliverer in whom the Gentiles were to trust, and who was to be the Desire of all nations. Other men than those who claim exclusively the name of critic must really be allowed to have some inner consciousness of their own—some power to recognize voices which are full to overflow of intimations from the spiritual world. It is impossible for any open-minded man to follow those lofty strains without recognizing the mystery and the majesty of their import. It is no more possible, when doing so, to listen to the carpings of the verbal critics than it would be to listen to the rasping noises of some petty mechanical operation when the thunders of heaven are pealing overhead.

And here I may be permitted to express a very strong opinion that in recent years Christian writers have been far too shy and timid in defending one of the oldest and strongest outworks of Christian theology. I mean the element of true prediction in Hebrew prophecy. It may be true that in a former generation too exclusive attention had been paid to it, and too much stress had been laid upon details. Nay, more, it may be true that the attempted application of prophecy to time still future has been the cause of great delusions amounting almost to religious mania. But the reaction has been excessive and irrational. A great mass of connected facts, and of continuous evidence, remains—which can not be gainsaid. Even if the greater prophets could be brought down to the very latest date which the very latest fancies can assign to them, they depict and predict overthrows and vast revolutions in the East which did not take place for centuries. It is easy to see how and why this reaction has arisen. Besides that mere swing of the pendulum which affects more or less all progress in human thought, a false analysis of physical science has intimidated men into a languid submission to that greatest of all fallacies which is embodied in the very word "supernatural." They tell us they can not believe in what they call the supernatural. But neither need they do so. For my own

* 2 Peter, i, 19.

part, I believe in nothing "above" nature or outside of it, which is not also in it, and visibly shining through it. It is so particularly with predictive prophecy. There is nothing more thoroughly in harmony with the system of things in which we live. The conception that all future events are connected with the present by the links of natural consequence, is a conception familiar to all science and to all philosophy. That those links should be capable of being followed, and their results foreseen by adjusted eyes, is quite according to the natural constitution and course of things. Prophetic prediction is implicit—to an almost miraculous degree—in the mysterious instincts of many of the lowest animals. It is explicit, more or less, in all the intuitions of human genius; and there is nothing difficult to conceive in this faculty being strengthened, intensified, and glorified, in minds whose relations with the spiritual world are close and special. In a more literal sense we may say of the Hebrew prophet what Tennyson says of the ideal poet:

> "The marvel of the everlasting will,
> An open scroll,
> Before him lay."

It is a comfort to observe that Prof. Huxley is not very sanguine as to the early triumph of his own nonsense. There is no ground, he says, "for much hope that the proportion of those who cast aside these fictions and adopt the consequence of that repudiation, are, for some generations, likely to constitute a majority." Certainly not. Prof. Huxley must know that the ranks of science are crowded with men, quite as eminent as himself, who are believers in Christianity. For more than "some generations" these men are likely to have successors. A few Christian sects have lately been showing signs of a disposition to divorce belief from facts, and from all definite conceptions of objective truth. An authority among them has lately uttered a warning voice. He has told them that they have in consequence been losing ground. "The undogmatic churches have reaped the scantiest harvest, while the dogmatic churches have hitherto taken the multitude."* This is bad hearing for Prof. Huxley. But it is good hearing for all who hold that morality itself can not be maintained except in connection with definite beliefs. The result, so disappointing to agnosticism, is the result of a great law—Nature abhors a vacuum. Men can not live on a diet of negations. Both our intellectual and our moral natures have digestive apparatuses of their own. They require their appropriate food, and Prof. Huxley has none to give them. The sect of the know-nothings is not likely to be ever popular, still less to overspread

* Address of the President of the Congregational Union at a late meeting.

the world. It is too barren, too empty-handed. It makes even science poor, robbing it of half of its intellectual interest and of almost all its charm. Men who talk about "plans," and "apparatuses," and "contrivances," and then tell us they don't mean what the words imply, are feeding themselves and us on husks indeed.

But Prof. Huxley has his revenge. In words which seem to express the most supercilious contempt, he refers to those who, "having distilled away every inconvenient matter of fact in Christian history, continue to pay divine honors to the residue." This is a bitter sentence. I do not think it is a just one as applied to the authors of the volume called Lux Mundi; but I fear it is more justly applicable to religionists of the Robert Elsmere type. Prof. Huxley ridicules them in a mock sentence supposed to be coming in some Bampton Lecture of the future: "No longer in contact with fact of any kind, faith stands now and forever proudly inaccessible to all the attacks of the infidel." I should not like to speak in this tone to, or of, any minds which are perplexed. But I agree with Prof. Huxley that, as flesh and blood must have a skeleton, so both sentiment and faith must have an object. They can not hang in air with no footing either in earth or heaven. Nothing can be more certain than that "nature" did not generate itself. The things which are seen were certainly not made of things that do appear.* The things which are seen are all temporal. It is the things which are not seen that are alone eternal. All this belongs to our universal experience, and is part of our all too scanty stock of necessary truths. What we call nature—ourselves included—must have had an origin and a cause. These are the objects of religion. Of two things we may be sure about theology: first, that there must be facts concerning it; and, secondly, that these facts must be the supreme facts with which we have to do. They may or may not be accessible to us, but they must exist as realities—with all their dynamic apparatus, and with all their corresponding laws. It is the business of all men to see those facts as best they may, and to obey those laws as best they can. It is impossible, therefore, to admire or even to respect the attitude of men who, in these matters, do nothing but stand by the highwaysides of life mocking. Least of all is this attitude to be respected in our professed agnostics. They should at least remember that they have nothing to give us of their own. Ignorance—even fictitious ignorance—is the motto on their flag. They do not plead it humbly as a confession, or use the sense of it as a stimulus to exertion. They claim it proudly as a boast, and use it as a weapon to repulse the light. With them knowl-

* Hebrews, xi, 3.

edge is "quite shut out," not because they have by nature no sense enabling them to see it, but because they choose to close its door and to starve it into atrophy. They are the men who can not rise to the higher interpretations even of their own science, or read the discoveries of their own dissecting knife. We accept their teaching as far as it goes, but we need not and can not accept their mastership. We desire to assimilate every fact which they can prove, and we are grateful for all the thought, and care, and labor, through which alone these facts have been established. But other men must be allowed to see other related facts to which experts may be blind. On any pure question of biology there is no man to whom we can go more safely than to Prof. Huxley. An original and careful investigator, a brilliant expositor, and in many things a cautious reasoner, he enjoys, on his own ground, a high and a just authority. But off that ground he passes into the shadows of a great eclipse. He labors under insuperable bias. Through this, and this alone, and through—we may be sure—no conscious unfaithfulness to truth, there is one great subject on which his judgment is warped by an obvious antipathy. On all questions bearing on "Christian theology" he is not to be trusted for a moment. Loud and confident in matters on which both he and we are profoundly ignorant, we see him hardly less boisterous in asserting ignorance where the materials of knowledge lie abundant to our hands. We have seen his canons of criticism—how rude and undiscerning; his claim for the physical sciences—how inflated; his own dealings with one of them—how shallow and how dogmatic. Prof. Huxley may depend upon it that the time has come when the great questions raised by the indisputable facts of Quaternary geology—of which the Deluge is perhaps the least important—must be taken out of the hands of men who, by his own confession, have hitherto dwelt with them in no voice more articulate than a smile, and in no attitude more intellectual than a shrug.—*Nineteenth Century.*

In a paper by Prof. Warren Upham, On the Cause of the Glacial Period, it is admitted, on the evidence afforded by a large number of recent independent discoveries and calculations, that the date of that period can not be set further back than about ten thousand years; the dates surmised by Croll and Geikie are therefore vastly exaggerated and impossible, and with them must fall the cosmical theory. Hence new causes must be sought. Prof. Upham looks for them in a higher elevation of the continent, which seems, however, to have been followed by a depression under the ice-sheet; a land barrier existing between Europe and Greenland, and shutting southern waters out from the Arctic Ocean; and a submergence of the Isthmus of Panama, turning the southern waters toward the Pacific Ocean.

MY GARDEN ON AN ONION.

By KATHARINE B. CLAYPOLE.

THERE was one great difference between this garden of mine and the gardens of my neighbors—an enormous difference, I might say—for, while they had onions *in* their gardens, my garden was *on* an onion. In fact, the onion was my garden, and in some respects this was an advantage to me. I had no soil to prepare, no seed to sow. I had merely to keep my onion a little moist, and the crops appeared of themselves.

The first to come was a sage-green down, appearing near the neck of the onion, just where the clear, shining scales close round the stalk. If the onion were put into the earth, this stalk would shoot straight up and bear a crown of flowers, followed by a crop of onion seed. It makes efforts to sprout even in a dark cellar. It pushes the scales apart, and the last remnant of life leaves them—of their own life, I mean, for, no sooner are they dead, than a host of tiny spores find life-food in their remains. These spores had been falling on my onion scales for months, but, so long as the scales were unbroken, could gain no roothold. Now thousands of them had pushed out little threads, which, branching and interlacing with each other, at last formed a film that the eye could see. Then quickly followed the sage-colored, velvety spots, and I knew that my first crop was ready for examination.

What was it?

The housekeeper called it mold. She said that my onion "had begun to get moldy." Mold is one of her deadly enemies. She recognizes it as a sign of rot or decay, and, wisely from her point of view, she gets rid of it as quickly as possible. I called it mold also—a mold. For I knew that before long there would appear other crops unlike this one, yet like enough to bear the name of mold also. I knew, too, that though these molds are almost too small to be seen by the naked eye, they have cousins that every one knows by sight. There are the mushrooms, the toadstools—yellow, red, and brown—the gigantic puff-balls, and many an odd-looking mass simply called "a fungus." The term fungus, or more often its plural form fungi, denotes a most persistent, industrious class of plants whose one aim in life is the production of millions and millions of spores. The sage-green spots on the neck of my onion were the spores of a fungus. With a needle I could scatter them like a cloud of fine powder. But I could not see how they were growing on the little plants without a microscope that would magnify them about three hundred times.

With such a microscope I saw transparent, branching, interlacing threads, called *hyphæ*, and thousands of loose spores. Many of the threads ended in little tassels. These tassels I found to be formed in a very interesting manner. First, the creeping *hyphæ* send branches into the air. Then these branches bear each three or four branchlets. From the ends of the branchlets grow a number of fine, parallel threads called *sterigmata*. The ends of these *sterigmata* contract and form little round, bead-like bodies commonly known as spores. As they are, however, actual bits of the branching *hyphæ*—bits exactly like the rest of the *hyphæ* in their constitution—they have no right to be called spores. The name *conidia* has, therefore, been made for them, from a Greek word meaning dust. As soon as each of these *conidia* or dust-like bodies is completed, another forms behind it, a third behind the second, and so on; the first being thrust forward until at last it is pushed off altogether and falls. The second shortly follows it, and then the third, and so the process goes on, old *conidia* falling off at one end and new ones forming at the other. It is these strings of *conidia* that give the tassel-like look to the ends of the aërial *hyphæ*. To the botanists who first studied them they suggested little brushes; the brushes that artists call pencils—camel's-hair pencils, for instance. The Latin name for brush being *penicillum*, this "brush"-bearing fungus received the name of *Penicillium*. Moreover, to distinguish a *Penicillium* with sage-green brushes, a second name, *glaucum*, was found. The first crop to appear on my onion was, thus, *Penicillium glaucum*, a fungus by no means confined to onions. My housekeeper has taken felted masses of it out of her cans of fruit; has bewailed its sage-green *conidia* on her jam, and even on her bread and pies. Indeed, she has to keep a sharp lookout for them, never knowing where they may next appear. I can only tell her that the air is full of them, and that they settle here, there, and everywhere, and will surely grow wherever they find moisture and nourishment to suit them.

Fig. 1.—Penicillium glaucum.

The next crop that my onion bore made grayish patches on the outermost of those juicy layers, the bases of last year's leaves. With the eye alone I could make out the separate little plants,

and, when I held a magnifying glass over them, it was like looking down on a fairy forest of brown-stemmed, branching trees covered with a luxuriant, silvery foliage. In this miniature tree I recognized a mold called *Polyactis* (many-branched), a fungus that is sure to show itself, sooner or later, on decaying vegetables. To remove one of the little trees and place it under the microscope required as much patient care as I could muster; for not only does the *Polyactis* take a firm hold of the leaf-base with its spreading, root-like *hyphæ*, but at the least jar it sheds its foliage, branches and all, and nothing remains but an uninteresting, pointed stem. Yet, if we could continuously watch this stem for a day or so, it would prove anything but uninteresting. Almost at once the protoplasm stored within it begins to form other branches as luxuriant as those that fell. When each is furnished with a due amount, a partition cuts it off from the main supply. Henceforth it rests merely upon the parent stem. It sends out branches on its own account, and gradually gives over its protoplasm to them. These branches fork and fork again, until at last the protoplasm is all concentrated in the ends of tiny branchlets, which swell and sprout all over with little points or *sterigmata*. Each little point contracts and then swells at the end to form an oval, bladder-like body. It is these oval bodies that give the look of foliage to the *Polyactis*, and as soon as they have received the whole nourishment of the branchlets they cut themselves off from their *sterigmata* and hang together in a grape-like cluster. These are the *conidia* that it has been the business of the whole plant to produce, and, in order that more may be borne by the same stem, they must speedily fall and carry the empty branches with them.

FIG. 2.—POLYACTIS CINEREA.

The third crop appeared where I least expected to see it—on the heads of my *Polyactis*. First of all, fine, silvery lines ran from one *Polyactis* tree to another, looking, through the magnifying glass, like part of some complicated system of telegraph wires. In a day or two they formed a perfect network, on which pink dots began to appear. The dots increased in number, and soon the *Polyactis* was completely covered with a pinkish film. The

film was pretty in itself, and I was forced to admire it, although I regretted the untimely extinction of my *Polyactis*. Shortly, however, it turned a dingy brown and fell to the onion, crushing the *Polyactis* under it. The *conidia* of the *Polyactis* germinated, and sent up another crop of tiny trees; but they had not run their little cycle of changes long, before the fine white lines appeared among them. The pinkish film followed, and then, again, film and *Polyactis* fell to the onion in a dirty-looking mass. The *Polyactis* took a fresh part of the leaf-base; the pink film followed it. *Polyactis* tried the inner side of the leaf-base; the film found it even there. The *Polyactis* crept up the sprouts that had burst through the scales; the film still pursued it—in fact, the *Polyactis* could grow nowhere on this onion without being overrun by the silvery threads. For days I watched the strife with naked eye, magnifying glass, and microscope, and saw the *Polyactis* gradually succumb and the onion itself rot and blacken under the repeated attacks of the pink-dotted film.

The microscope showed the film to be a tangle of fine, transparent *hyphæ*, and the pink dots little balls containing spores. Very beautiful are these *Baryeidamia* spore-balls, changing, as they mature, from pink to a rich seal brown, and surrounded always with clear, scalloped edges. In such profusion, also, are they produced that hundreds of them may be taken up at once on the point of a needle.

FIG. 3.—POLYACTIS OVERRUN BY BARYEIDAMIA PARASITICA.

Though the most successful, these were by no means all the crops that my onion bore; at least three other minute fungi struggled for existence, but could gain no headway against the pink-filmed *Baryeidamia*. These, like the *Penicillium*, *Polyactis*, and *Baryeidamia* itself, were all of a comparatively harmless kind. They were merely scavengers, seeking their living on parts of the onion already dead, and thriving on material that it no longer had power to use. The onion, however, had nourished at least one fungus of a very different nature. My microscope showed me its clear, crescent-shaped *conidia*, and in the tissues of the leaf-bases its *hyphæ* were creeping from cell to cell, stealing

the nourishment prepared for next year's sprouts. This fungus is a thief preying on the industry of the onion—it is more than a thief, for its ravages leave destruction and death in their wake.

The warmth and moisture necessary for the growth of my crops were not good for the onion. It developed untimely, sickly sprouts from the interior layers, while the exterior became the prey of swarms of those minute forms of life known as *bacteria*—forms that lie, as it were, in the border-land between plant life and animal, and whose function it is to resolve complicated organic structures into their original elements. Under this process my onion sank into a mass of putrescence so ill-looking and ill-smelling that, ere its original elements were reached, I committed it to the swifter dissolution of the flames.

EVOLUTION OF PATENT MEDICINE.

By LEE J. VANCE.

"THIS wonderful remedy works like a charm"—so reads a bold advertisement now lying before me. Why should any patent medicine work like a "charm"? The modern notion of a medical remedy working like a "charm" is a survival of the belief that certain secret remedies are charms. This is the savage's view of all medicines. He mixes his medicines with magic. His remedies are magical remedies, his songs of healing are incantations, his prayers for restoration to health are magic formula, his doctors are magicians.

Patent medicine had its origin in folk medicine. We are thus enabled to examine patent medicine as a magical practice and art of gradual development and of slow and subtle transformation. We shall argue that the blind, unthinking faith in a secret compound known as "patent medicine" is, for the most part, a survival. Further, we shall be able to show how magical practices, as of the Indians, develop into the remedies of the folk, of the people who share least in progress; how folk practices, in turn, in the hands of the mediæval leech and alchemist, become "occult science"; how, finally, out of leechcraft and quackery was evolved our curious system of patent medicine. The modern doctor is the heir of the leech, apothecary, and alchemist. He too seeks the elixir of life. He now makes a lymph more wonderful than the witches' ointment, which enabled people to sail through the air.

Briefly stated, patent medicines are drugs compounded of unknown ingredients, and are intended for the relief or cure of the various ills that flesh is heir to. They always have been, and still are, prepared and put up in an entirely different way from

all other medical compounds. In one sense, the word "patent" means plain or unconcealed, but that is the reverse of the meaning of the medicine in question. Time was when the state, for purpose of revenue, allowed the venders of medical mixtures to take advantage of the patent law. By an act of Parliament a duty was levied on bottles or packages containing prepared drugs, and a stamp showed that the tax had been paid. This regulation was early adopted by the United States, but a few years ago the law was wiped off our statute-books, and, to-day, no tax or license is necessary.

Now, in all patent medicines, whether ancient or modern, there are two elements—the element which we now regard as *magical* and that which we regard as *mysterious*.

The notions entertained of medicines and medicine-men by people in a low stage of culture are pretty much alike in different parts of the world. Everywhere savages attribute disease to evil spirits, revengeful enemies, and to various occult influences. Naturally enough, priests among rude people are doctors, and doctors are priests. The medicine-man is priest-doctor. Mr. Mooney, who has made a thorough study of the theory and practice of Cherokee medicine, observes that "every doctor is a priest, every application is accompanied by a prayer and a sacred song." He found that plants were selected on account of "some connection between their appearance and the symptoms of the disease."*

Here we meet with the magical element in medicine; for it is one of the recognized principles of magic that things like each other, in color or form, influence each other in a mystic way. On this belief in a real and material connection between an object and its image, or between things like each other, is based one half of the magic of ancient and mediæval times. Thus, the Cherokee doctor invariably prescribes a yellowish decoction for biliousness. Believing that heart troubles are caused by the lungs becoming wrapped up about the heart and impeding its action, the patient is treated with a preparation of fern leaves, because these leaves when young are coiled up, but unwrap as they grow older. Again, the medicine-man not only works on analogy or resemblance, but his remedies are put up in a mysterious way. The patient must not know the kind of stuff he is swallowing. According to Dr. Archie Stockwell,† the Indian doctor thinks that "a remedy to be of any value should be secret." To the same effect is the testimony of another expert.‡ "To keep their medicine from the gaze of the profane, a medicine-bag is prepared

* Journal of American Folk Lore, vol. iii, p. 42.

† Popular Science Monthly, September, 1886.

‡ Smithsonian Reports, 1886, Part I, p. 246.

from the skin of birds or small animals"—so writes Mr. Paul Beckwith.

Once more, certain plants and roots are endowed with magical virtues, chiefly in the way of charms. Like the Homeric Greeks, semi-cultured people believe that "certain roots ward off the evil influences of spirits." Mr. Theall well puts it, when he says that "charms and medicines are classed together by the Kaffirs." Among the ancients the art of medicine was little more than a trade in charms, philters, and amulets. In his history of folk medicine, Mr. Black mentions many of these curious remedies. Let it, therefore, be enough to say that all folk nostrums are believed to work like charms; otherwise they would not be prescribed.

The patent-medicine man can put anything he likes in his preparation, because his patients have unquestioning faith in nostrums mysteriously compounded. Thus, when the Chinese physician is out of drugs, he writes the prescription on a piece of paper, rolls it into pills, and the sick man swallows it. The whole theory of early patent medicine is based on analogy or on the association of ideas: for example, it makes no difference whether you swallow the name of the remedy or whether you take the remedy itself.

This theory was fully worked out in the mind cures and faith cures of the middle ages. Study the origin and history of plant names. Scan the list, and what do you find?

Some plants have animal prefixes, as dog-elder, dog-rose, cat's-tail, cow-bane, etc. Other plants derive their names from religious sources. Thus they are associated with the Virgin Mary, Saint John the Baptist, Saint James. Likewise, the Latter-day Saints have particular plants dedicated to their memory. Most of the plants with mystic names were supposed to have magical virtues, and so they were largely used in folk medicine. The weird associations clustering around many roots and herbs were enough to invest them with great repute. According to Mr. Dyer, "the plants which formed the witches' pharmacopœia were generally selected either from legendary associations or by reason of their poisonous and soporific qualities." In folk medicine, herbs are used not so much for their inherent medical properties as for their reputed magical virtues.

Another stage in the evolution of patent medicine is typified in the therapeutics of mediæval mystics and alchemists. The great plant in their pharmacopœia was the mandrake. Why? Simply because the roots of this plant were shaped like the human body. A preparation of mummy was also widely used. Why? On the magical reasoning that flesh thus embalmed would preserve the body impregnated with it. Then the alchemists be-

lieved that a solution of gold had great medicinal virtues. Why? On the theory that the strength and quality of the metal might be communicated to the body of the person taking it. Still more potent than the *aurum potabile* was the *elixir vitæ*, by which people preserved their youth and lived forever.

The magical element in patent medicine actually won scientific repute in the "doctrine of signatures"—a doctrine which held that plants and minerals, by their external character, indicated the particular disease for which Nature had intended them as remedies. Thus the *Euphrasia*, or eyebright, was good for the eyes; the wood-sorrel, being shaped like a heart, for the heart; the liverwort for the liver, and so on. Pettigrew, in his history of medical superstition, says that this fanciful and magical notion "led to serious errors in practice," and often to fatal results.

Observe that, at this stage of its evolution, patent medicine is herb medicine, and so it remained for a long time. The materials of the healing art were all vegetable. The patent-medicine man was a dealer in herbs, and his shop is well described by Romeo:

> "And in his needy shop a tortoise hung,
> An alligator stuffed, and other skins
> Of ill-shaped fishes; and about his shelves
> A beggarly account of empty boxes,
> Green earthen pots, bladders and musty seeds,
> Remnants of pack-thread and old cakes of roses,
> Were thinly scattered, to make up a show."

In those days the barber-surgeon and the apothecary were the recognized exponents of the healing art; to them patients repaired for treatment. "The students of medicine," Mr. Goadby, in his England of Shakespeare, says, "were usually extensive dealers in charms and philters." They were as ready "to sell love-philters to a maiden as narcotics to a friar." The Arabic physicians introduced chemical and mineral remedies into European pharmacopœias, and then patent medicines took a turn for the worse.

The mantle of alchemists and witches seems to have fallen upon certain "wise" men and women, whose medicinal preparations were invested with a dash of magic; so that their nostrums were held in popular favor. Lord Bacon complained of the weakness and credulity of men in his day. "They will," said he, "often prefer a mountebank or witch before a learned physician." Secret preparations were put up by physicians of repute. Thus, Sir Kenelm Digby made a sympathetic powder which was reputed to cure wounds. He even published a book of Choice and Experimented Receipts in Physick and Chirurgery. The efforts of physicians were directed to the invention of nostrums and charms, not to the cause of the disease or to the action of their remedies. Throughout the seventeenth and eighteenth

centuries the manufacture of "secret" preparations increased enormously, and "choice receipts" were sold for large sums. Thus, the English Government paid one thousand pounds to one Johanna Stevens for her mysterious specific for the stone, which turned out to be calcined snail-shells.

Indeed, the sale of nostrums in England had now grown to be a most flourishing and profitable business. To such proportion did the trade grow that at last the Crown stepped in and demanded a duty and a restriction upon prepared drugs.

The two statutes which originated and regulated the right of compounding preparations of medicines were passed in 1783. The first act granted to his Majesty "a stamp duty upon all licenses to be taken by certain persons uttering and vending medicines, and certain stamp duties on all medicines sold under such licenses, or under authority of his Majesty's letters patent, except such as had served a regular apprenticeship to any surgeon or apothecary as chemist and druggist."

Two years later, by act, 25 George III, chap. 22, other and more liberal conditions and privileges were granted, as follows: "Any person whatsoever who has, or claims to have, any secret art or sole right of compounding preparations of drugs, and advertising and recommending the same as specifics for the cure or relief of any complaint or malady, shall affix a Government stamp to the vials, vessels, or inclosures containing them."

Any one who violated the statute or who defrauded the state of the stamp duty was adjudged a felon. In the strong words of the statute, such a person "shall suffer death, as in case of felony, without benefit of clergy."

These statutes remained on the books, with little alteration or amendment, for nearly a hundred years. In 1868 the Pharmacy act was passed "to regulate the sale of poisons for the safety of the public." But section sixteen expressly says that "nothing heretofore contained shall extend to or interfere with the making or dealings in patent medicines." In 1875 another act was passed to the effect that, "a uniform duty of five shillings be payable throughout Great Britain."

The general patent acts of the United States were passed in 1790. They follow, in many respects, the old English legislation on the subject. The sole right of compounding medicines was allowed under the phrase, "composition of matter." What may be patented? The law says, "any new and useful art, machine, manufacture, or composition of matter." See the result. To take a noteworthy example: a patent was denied to the discoverers of the anæsthetic powers of chloroform and ether, but quacks, with their nostrums, could take out patents. In 1874 a law was passed abrogating the practice of copyrighting labels for patent medi-

cine or other articles of manufacture, and, instead, provided for registering such labels in the Patent Office. Several States still have "trade-mark laws," by means of which the name of a popular patent medicine is secured against imitation.

In our own day, the patent-medicine business has developed into alarming proportions. There never was a time when so many people put faith in patent compounds. There never was a time when so many nostrums with mysterious ingredients have been sold. And, lastly, there never was a time when nostrums had so few claims in the healing art.

It is surprising that the American people still retain their faith in patent medicines. Rather than pay an educated physician a fee of two dollars, some people will spend that amount for a bottle or a box of patent medicine. They will try one nostrum after another until they are cured or killed. The superstition is not confined to the common folk alone. People who should know better are among the best customers of the nostrum-vender. The steady purchasers of patent medicines are the poor and ignorant. To be ignorant is to be credulous, and it is to the credulity of our people that the nostrum-vender appeals so strongly. The farmers and their families are afraid of the doctor, but they make riends with the quack. A correspondent of the New York Sun, in describing the peculiarities of Western farmers,* says: "If one patent medicine fails, it is because it is not the right patent medicine, and they try another. They prefer patent medicine, partly because there is a certain mystery about the ingredients, and they are put up in an attractive form."

It is not easy to calculate how many millions of dollars are spent by Americans on patent medicine every year. Think of the enormous expense required to keep a preparation before the public eye—calendars, almanacs, cook-books, cards, high-priced articles in all the daily papers. Of course, the money to pay for this comes from only one source—from people who buy the stuff. The sale of a certain "vegetable" compound is said to have amounted in one year to three million dollars, and one third of that went the next year in advertising. Now, to yield three millions at least six million bottles must have been sold. That gives one some idea of the number of people who use such preparations.

It would appear, then, from the lavish manner in which our people pour out their hard-earned money, that they like to be humbugged, so the veteran Barnum once bluntly remarked. If they want to spend their cash for patent medicine, is not that their own business? Yes; but should not the law step in and save the poor and ignorant from their own folly? No; that very

* Aug. 24, 1890.

question came up in a patent-medicine case in New York State.* The judge tersely summed up the whole matter thus: "As to the public, if these pills are an innocent humbug, by which both parties" (the litigants) "are trying to make money, I doubt whether it is my duty on that question of property, of right and wrong between them to step outside of the case and abridge the innocent individual liberty, which all persons must be presumed to have in common, of suffering themselves to be humbugged."

But the trouble is, that too many patent pills and medicines are not "innocent" humbugs. On the contrary, a large class of patent preparations are deadly poisons. We do not call medicine in which chlorodyne, calomel, or opium is an ingredient, "innocent." We need only point out that most soothing-sirups contain opium; that most face preparations have arsenic and oxide of zinc; that most "stomach bitters," so called, are composed of powerful drugs or whiskey, principally; that most of the health-restorers contain narcotics.

The unrestricted sale of secret or quack medicines is objectionable. It has now become a matter of serious importance; it renders murder, suicide, and crime easy. People injured by taking patent medicine are not without a legal remedy. The Supreme Court of Georgia recently decided that nostrum-venders are liable for damages to any person who, relying upon their cleverly worded testimony, takes their baneful stuff.† To quote from the decision: "These proprietary or patent medicines are secret, or intended to be secret, as to their contents. They" (the venders) "expect to derive a profit from such secrecy. They are therefore liable for all injuries sustained by any one who takes their medicine in such quantities as may be prescribed by them. . . . He" (the victim) "has a right to rely upon the statement and recommendation of the proprietor, printed and published through the world."

It is time that some restrictions were thrown around the sale of patent medicines. Venders of secret remedies practice cruel and dangerous deception. The traffic in some sixty thousand nostrums, many of them containing deadly drugs, has given rise to an anomalous state of affairs. For obvious reasons, the law should compel nostrum-venders to make public the names and proportions of the ingredients. That is what is done in other countries. Even the Japanese are in advance of us in regulating the sale of patent medicine. They compel the proprietor of a secret remedy to present a sample, with the name and the amounts of the ingredients, directions for its use, and explanations of its supposed efficacy. Or, we might adopt the French plan of making

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* 18 Howard's Pract. Reports, 242.

† The Blood Balm Company *vs.* Cooper, decided October 14, 1889.

nostrum-venders declare the composition on a label and to submit the stuff to official analysis. In England, as in this country, the unrestricted sale of patent medicine has been again and again discussed in print, and the absence of proper legislation there has allowed quacks and impostors to grow and flourish.

Frankly speaking, nostrum-venders no longer rely on the curative power of their drugs. They depend now on the power of advertising almost exclusively. They have a literary man to "write up" the remedy in ingenious fashion; an artist to show the patient "before and after" using the panacea; a poet to compose odes and lyrics; a liar who rivals Munchausen; and a forger who signs all kinds of testimonials. The great point seems to be to make people feel that they are in the last stages of decline. A cleverly worded circular is enough to give one a fit of the blues. In the opening chapter of his amusing book, Three Men in a Boat, Mr. Jerome hits off this particular point. "I never read a patent-medicine advertisement," says one character, "without being impelled to the conclusion that I am suffering from the particular disease therein dealt with, in its most virulent form." It is not uncommon for the nostrum-vender to offer one thousand dollars reward for any case he fails to cure. He is safe enough, even if the remedy kills, for there is no time specified within which a cure is to be effected.

To this, then, patent medicine comes at last: "This wonderful remedy works like a charm," or else not at all.

THE FRENCH INSTITUTE.

By W. C. CAHALL, M.D.

THE Institute, as it exists to-day, is a creation of Napoleon, and, like all other organizations which arose under the First Consul, reveals his disposition for centralizing and supervising everything, even the literary and scientific societies. It is due to Napoleon, however, to say that he had a professional interest in these societies as well as a ruler's, for it must be remembered he was an engineer, and had a seat in the Academy of Sciences. While the Institute dates from Bonaparte, who modified the newly organized Institute of the Directory, the several academies of which it is composed are very much older. The Consul simply revived the academies in almost their original form, but placed them in a more intimate relation with the Government and with each other.

The Institute may be likened to a university, while the academies are as the colleges of a university, independent yet correla-

tive. Just the contrary prevailed in England, for here the Royal Society was the mother society, and all the organizations for special study have been offsprings from her.

A century of honorable and useful works could not save the academies from the insatiable maw of the revolutionary Government, and on the 8th of August, 1793, the following article was proposed and passed: "Article I. All academies and literary societies patented and paid by the nation are suppressed."

When, two years later, the Directory restored and reconstituted the academies into the Institute, after the original plans of Colbert, the empty chairs of the old members told with what deadly thoroughness the Revolutionary Committee suppressed the learned bodies through the guillotine and exile.

There had been the *Académie Française*, *Académie des Inscriptions et Belles-Lettres*, *Académie des Sciences*, and *Académie de Peinture et Sculpture*, now styled *Académie des Beaux-Arts*. Under succeeding governments the Institute and its academies underwent various changes as to name and classification of sections, but as they exist to-day the several academies are fulfilling practically the same aims and functions with which they started. A fifth academy was added by Guizot in 1832, as *L'Académie des Sciences Morales et Politiques*.

I. The *Académie Française* is the oldest, and in many respects, the most illustrious of the five.

The great Cardinal Richelieu, betwixt his intrigues of state and his more laborious task of writing indifferent tragedies, found time to play the patron to a *coterie* of learned men, who met at regular intervals for social and intellectual intercourse. Whether through his political insight or literary ambition it is not possible to know, but he clearly foresaw what a powerful influence such a society might wield, and esteemed it good statecraft that the Government should hold a supervisory interest. All was grist that came to his mill. For several years, or as early as 1630, Godeau Gombauld, Giry Habert, Serisay de Malleville, Chapelaine, author of La Pucelle, and other literary men of note, had been accustomed to meeting weekly at the house of Conrart, secretary of Louis XIII, where literary subjects were the usual topics, and where new works of the members were read. Since even such harmless societies were contrary to the law of France, strict secrecy was enjoined. But Richelieu had ears all over France. In 1633 Malleville took with him to the meetings his friend Farey, who, in all innocence, introduced the Abbé Bois-Robert. This satellite of the prime minister proved to be the ears in this instance, and reported to his master the excellence of these gatherings. Richelieu lost no time in offering to act as patron to the society, extended to it his protection, and promised letters of incor-

poration. The members would have been quite content to have continued their meetings in their former quiet, informal way. At the same time the condescension of the august prelate was not to be gainsaid, for, while he could purr as gently as a cat, he could strike with equal swiftness when it suited his purpose. A prime minister, in those days, preserved his own head by cutting off the heads of others, and the gentle priest had become wonderfully expert at this business.

With commendable promptness the members meekly drew up a code of regulations. They were to have only forty members. The officers were to consist of a director, who should preside over their deliberations; a chancellor, who should act as keeper of seals; and a permanent secretary.

The title of "The French Academy" was adopted, and its object was avowed to be "to labor with all care and diligence to give certain rules to our language, and to render it pure, eloquent, and capable of treating the arts and the sciences. It shall be the object of the new academicians to purge out of it those impurities with which it has become polluted."

The cardinal passed the statutes, and the king signed the letters patent on the 2d of January, 1635. When the Chancellor of State, Peter Seguier, impressed the charter with his great seal, he expressed his wish to become a member.

So far all was smooth sailing; but the Parliament of Paris, whose assent was necessary before the Academy could become legally constituted, proved obdurate, and it was not until after two years and a half, with all the powerful influence of the king, and his more dreaded prime minister giving it urgency that the coveted act was passed, with the qualification, however, that the academicians should "bind themselves to take cognizance of no other matters than the embellishment and enriching the French language, and to sit in judgment upon no books save such as were written by their own members, or by authors who should willingly submit themselves to academic discipline."

As a balm for their wounded feelings, the Government decided that each member of the Academy should receive an annual pension of two thousand francs. It was a source of no little scandal when it became known that they were paid out of a fund of forty times two thousand francs, which had been appropriated to pay the scavengers of the streets of Paris. The members themselves did not escape a just popular censure for the complacent manner with which they allowed themselves to be used by the wily cardinal.

The condemnation of The Cid of Corneille, which Richelieu instigated Chapelaine to write and the Academy to pass, will always be remembered against them. Much has been made of

this incident, and the rejection of Molière, Boileau, La Bruyère, and Pascal; but these were almost the only exceptions to the rule that the greatest names in French literature were among the "Forty Immortals." And, as a matter of fact, Corneille was later on elected to membership, as were also Boileau and La Bruyère. If Molière was rejected because he was an actor, is it not currently reported that Henry Irving in our day is denied a knighthood for a like reason? But even of this action the Academy has thought better, for Molière's bust, which has been placed in the *Salle des Séances*, bears these words, "Rien ne manque à sa gloire; il manquait à la notre."

There are no two opinions as to the influence of the Academy upon the French language. It can be said, almost without exaggeration, that the French language has made greater conquests than the French army, for surely it has subdued courts where the French soldier had been impotent. As to its efficiency as a vehicle for literature classified as *belles-lettres*, it is the language *par excellence*, and its influence upon the world's literature is still tremendous. In clearness of expression, in perfection of form, in all that is meant by style, the French language is perhaps second only to the ancient Greek.

What the schools and philosophers of Athens did toward the perfection of the Ionic dialect, the French Academy has done for the French. Could there be any higher term of encomium than this? Yet this is the heritage of the Academy—not of one individual or of one generation, but of the accretions of generations of men laboring toward one end.

II. *Académie des Inscriptions et Belles-Lettres.*

III. *Académie des Sciences.*

IV. *Académie des Beaux-Arts.*

V. *Académie des Sciences Morales et Politiques.*

From the halcyon days of *le Grande Monarque*, three of the academies—II, III, and IV—date their beginning.

L'Académie des Inscriptions et Belles-Lettres, originally appointed to prepare inscriptions and mottoes for medals for King Louis XIV, became a chartered body under Colbert in 1663, when its scope was widened by assuming as its province the discussion of archæology in its various bearings.

L'Académie des Beaux-Arts arose from the *Académie de Peinture*, founded by Le Brun in 1648, and enlarged and incorporated by Colbert in 1664, as the *Académie Royale de Peinture et Sculpture;* it busies itself with painting, sculpture, architecture, and music.

L'Académie des Sciences Morales et Politiques is the youngest of the five, dating only from 1832, and has for its especial investigation mental philosophy, jurisprudence, and political economy.

L'Académie des Sciences, like the Royal Society of England, had a pre-official existence. A company of scientific men were accustomed to meet weekly at the house of some of the members in order to discuss, in an informal way, the current scientific topics of the day. Colbert, with wise discernment, saw that it would be advantageous to give them official recognition. He induced Louis XIV to bestow upon the newly organized body extensive grants for pensions, experiments, and instruments. Under this provisional charter the Academy met for the first time on December 22, 1666, in the rooms of the Royal Library. From this time forward a regular account of the proceedings has been kept, and for the first time it was called *L'Académie des Sciences.*

Within the very year of Colbert's incorporating the Academy there was returned to Paris for interment the body of one who, more than any one else, gave life and direction to the Academy during its earlier and more informal years. Although having spent the greater part of his life in Holland, Descartes was a Frenchman, and lived for a while in Paris, where, in fact, many of his greatest physical investigations were begun. Descartes was a ferment. Already in England Bacon had cut himself loose from the Aristotelian philosophy of the school-men. Descartes followed with a similar upheaval upon the Continent. Yet the two philosophies were in no way akin, save in the interest their works aroused for the study of nature. In Bacon's shameless race for state honors his philosophical studies were but diversions; consequently his philosophy was vague and undefined. To Descartes, in his almost ascetic life, his philosophical studies became an all-absorbing passion; consequently his system of philosophy, if not clear in all its details, was pointed and forceful, and swept as if by storm over both the scientific and metaphysical worlds.

Colbert, pursuant of the policy of Louis XIV to make Paris the intellectual as well as the political center of Europe, invited Huygens to leave the Hague and take up his residence in Paris. This he did in 1666, France receiving from Holland this celebrated mathematician and astronomer in exchange for her loss of Descartes, who gave the best part of his life to that country. Huygens was not the only foreigner whom the honors and pensions of Louis XIV induced to leave their native land; Römer, a Danish astronomer, and the great Italian astronomer, Dominic Cassini, being among the most eminent. Since the astronomical labors of these three men were so interwoven and interdependent, they can be considered together.

The Observatory of Paris was established in 1667, eight years before the Observatory of Greenwich was built. The French monarch appointed Cassini as the first director of the National

Observatory, and it is a remarkable fact that for four successive generations, covering a period of one hundred and twenty-two years, a Cassini was the director of the Paris Observatory. Dominic Cassini gave so much promise that at the age of twenty-five he was appointed Professor of Astronomy at the University of Bologna, and his reputation had already become so great that when Louis XIV, through his ambassador, requested Pope Clement IX and the Senate of Bologna to permit him to go to Paris, they yielded only for the limited term of six years. But, once in Paris, Louis XIV knew how to keep him.

The young Academy of Sciences received a great impetus through the labors of such men as Römer, Huygens, Cassini, Picard, and Mariotte. Cassini completed the unfinished work of Huygens's observations, and Huygens could not have elaborated his doctrines of the undulatory theory of light had not Römer just previously proved the velocity of light.

It was universally believed and taught that light was instantaneous. Römer observed that the eclipses of the satellites of Jupiter were earlier or later than the calculated time according to the time of year. He discovered that the premature eclipses always occurred when the earth was in its orbit nearest to Jupiter, and the delayed eclipses when farthest away; that the difference in time was about eleven minutes, which he correctly assumed as the time it took light to traverse the orbit of the earth. The velocity of light was thus mathematically established and measured. This discovery of Römer was made use of by Huygens in his development of the undulatory theory of light.

Hooke had, indeed, in his Micrographia, suggested some such an explanation of light; but to Huygens justly belongs the great honor of giving his theory a scientific basis. He taught that light was propagated in waves spherically, after the manner of sound. The adherents of the emission theory of light argued that light only moved in straight lines, but not around a corner as sound does, and as light should do if it moved in like manner.

The point was well taken, and for a long while was the stumbling-block in the way of the undulatory theory. Huygens met this objection, and time has proved its correctness. He says light will not be diffused beyond the rectilinear space when it passes through an aperture, "for, although the *partial* waves produced by the particles compressed in the aperture do diffuse themselves beyond the rectilinear space, these waves do not *concur* anywhere except in front of the aperture."

The adaptation of the pendulum to clocks by Huygens was of inestimable value to astronomy by furnishing a standard measure of time. His method of grinding lenses so improved the defining power of telescopes that he was enabled to discover the true na-

ture of the ring of Saturn, which Galileo, with his more imperfect instrument, failed to make out. He also discovered one of the satellites of Saturn, but refused to look for more, since there were now as many satellites discovered as there were planets, and, from a false conception of the harmony of the universe, he considered it useless to search after others. He had the mortification of witnessing the success of Cassini in discovering four others.

In January, 1699, a new charter was granted to the Academy of Sciences. Until this time its charter was only preparatory, no provision having been made for the government of the society, its purpose, or the election of new members. The new charter provided for twenty *pensionnaires*, three geometricians, three astronomers, three chemists, three anatomists, three botanists, three to study mechanics, one secretary, and one treasurer; twenty associates, of whom eight may be foreigners; twenty *élèves*, or pupils, who acted as assistants to the associates; and ten honorary members. At the beginning of the year each member must declare the object of his study for the coming year, and all experiments must be repeated and tested by the Academy as a body. The Academy could not fill the vacancies in its own membership, but must recommend two or three candidates for each vacancy, and the Government had the right to make the selections from those recommended. The king had rooms fitted up for the Academy in the Louvre, where the organized body met for the first time April 29, 1699.

Under the labors of the Cassini, Malebranche, Fontenelle, Tournefort, Maraldi, and Méry, the reputation of the Academy of Sciences continued to increase until the growing luster of Newton's investigations and those of other members of the Royal Society threw it somewhat into shadow. Unfortunately, a spirit of national jealousy caused the scientists at Paris and London to misunderstand or willfully underestimate the services of their rivals, which delayed the settlement of many scientific questions longer than was otherwise necessary.

It was said of Fontenelle, who was Secretary of the Academy of Sciences for forty-two consecutive years, that when his Géométrie de l'Infini was submitted to the Academy, he declared, "There, now, is a book which only eight men in Europe can understand, and the author is not one of the eight."

While the Cassinis were for so long time making their name famous at the Paris Observatory, there lived in Paris a family of Jussieus, five in number, and through a period of nearly a century and a half, whose labors in the *Jardin du Roi* and Academy of Sciences made them equally famous as botanists. With the Jussieus arose the "natural method" of botanical classification, as it is known, in contradistinction to the artificial of Linnæus.

Linnæus found botany a chaos and left it a rigid science; yet Linnæus acknowledged his system to be artificial. "Artificial classes," says he, "are a substitute for natural till natural are detected," thus anticipating the better method in a riper time; and by a curious coincidence in the very year of his death, 1778, Antoine Laurent de Jussieu began writing his Genera Plantarum, which contained the proposed classification.

The honor of the invention of the natural method belongs to Bernard de Jussieu, who made use of it in the arrangement of the garden of the Trianon in 1759, rather than to his nephew, Antoine, who elaborated, perfected, and published it. The classification of the Jussieus was more philosophical than that of Linnæus, and eventually superseded, but did not destroy it; it arose rather as a superstructure upon Linnæan foundations, and built along the lines which Linnæus had already marked out. The Genera Plantarum has been characterized by Cuvier as a work "which perhaps forms as important an epoch in the sciences of observation as the Chimie of Lavoisier does in the science of experiment."

Antoine Laurent de Jussieu's Genera was scarcely finished before Paris ran mad. It was the time of the Revolution. Happily for him that his profession as physician kept him busy in the hospitals and out of public life during these terrible days! The comparative obscurity of his life at this time allowed him to safely pass through the bloody ordeal which destroyed equally innocent and noble-minded men. There was no head which the guillotine cut off that could not have been better lost than that of Lavoisier.

Black, Cavendish, and Priestley, in England, and Scheele, in Sweden, had been making invaluable discoveries in chemistry, but chemistry was still in disorder. Lavoisier's mental equipment placed him at the fore-front of the scientific experimenters of his day, and there was no one so well qualified to perform his chosen work in chemistry as himself.

In 1778, in a memoir to the Academy of Sciences, Lavoisier questioned the existence of "phlogiston," and attributed to oxygen the acidifying principle. A second memoir, in 1784, on the analysis of water, confirmed his position. In conjunction with other French chemists, he substituted for the cumbersome chemical terms a nomenclature of such scientific accuracy that, with slight modifications, it continues to the present day. Its way thus prepared, his Traité élémentaire de Chimie, which contained his innovations and came out in 1789, proved a death-blow to the phlogiston doctrines, and prepared the way for modern chemistry. A chemist of such qualifications was very naturally called into requisition by the state. He increased the explosive quality of gunpowder, devised a system of weights and measures, and served

for twenty-one years as one of the *fermiers-généraux*. When the Academy of Sciences was suppressed in 1793, Lavoisier wrote to Lakanal, President of the Committee on Public Instruction, that the members of the Academy had formed a private society to continue their labors, and asked permission to use the Academy rooms. But even this privilege was denied them.

On the 2d of May, 1794, a general indictment was made in the National Assembly against the *fermiers-généraux* for *conspiring* against the Government, on the ground that they caused an adulteration of tobacco by the addition of water. Absurd as this charge appears to us of saner days, these men, including as they did some of the noblest of France, were actually tried, May 6th, and condemned to death, the entire body of twenty-eight being guillotined on the 8th of May, 1794.

After two years and a half of suppression the academies were revived by an act of the Convention of October, 1795, under the title of the "Institute," principally through the influence of Carnot, grandfather of the present President of France, who was at that time President of the Directory, and of Lakanal and Daunou. Instead of academies the Institute was divided into three classes, the first class for *sciences physiques et mathématiques*, the second class for *sciences morales et politiques*, and the third class for *littérature et beaux-arts*. The whirlwind of the Revolution swept away Directories and set up others. Carnot was obliged to fly for safety into Germany.

The seat in the class of mechanics of the Institute made vacant by the flight of Carnot was filled in 1797 by the election of a young artillery officer, Napoleon Bonaparte, just returned from his Italian campaign covered with glory. The First Consul paid much favorable attention to the Institute, and it continues to this day very much as it left his hands in the new constitution which he gave it in 1806. He exhibited his admiration for the pure sciences, and his dislike to the speculative sciences, philosophy and ethics, by the expansion of the Convention's first class and the entire suppression of the second class, thus creating four classes: *Sciences physiques et mathématiques, la langue et la littérature françaises, histoire et littérature anciennes*, and *beaux-arts*. It was Louis XVIII who, in 1816, restored the old names of the academies to the four classes of Napoleon.

Napoleon was fond of the society of scientists, and rewarded with prizes and honors the most noteworthy of scientific discoveries. Although at war with "*perfide* Albion," as he was wont to call England, he drew the line at scientists, and pardoned English prisoners at the simple request of Joseph Priestley, after all other means had been exhausted, and acceded to the award of three thousand francs by the first class of the Institute to Davy for his

celebrated memoir of 1806. It was Bonaparte who proposed to award a gold medal to Volta, after reading his memoir on galvanism; and later induced Volta, by emoluments and titles, to surrender his Italian professorship for a residence in Paris. When the memorable expedition to Egypt set sail, Bonaparte took with him many *savants* and Academicians. After the wager of battle had turned against the great soldier, and he was transported to the lonely St. Helena, he must have felt that the last tie to France had been severed when, in 1817, he felt forced to resign his chair in the Academy of Sciences.

Napoleon's battle of the Pyramids and conquest of Egypt added little to his fame; but his soldiers, in throwing up intrenchments near Rosetta, dug up a long-buried stone, in time to be esteemed more valuable than a dozen victorious battles. This stone, which took its name from the place of its discovery, became known as the Rosetta Stone. It was found to be of black basalt; about three feet seven inches in length and two feet six inches in width, and covered with strange-looking inscriptions. The stone finally found its way to the British Museum, where it still can be seen, and where for many years scholars studied it in vain before its incalculable archæological value was discovered. The inscription was found to be trilingual, the upper lines being in the hieroglyphic, the second in the demotic, and the third in the Greek language. The Greek was soon translated and found to contain a decree in honor of Ptolemy Epiphanes by the Egyptian priesthood, and erected nearly two hundred years B. C. The inscription being identical in the three languages, the Greek thus became the key by which the hieroglyphics of tombs and obelisks, which had so long baffled the ingenuity of acutest scholarship, were easily deciphered. "The learned walls with hieroglyphics graced" became an open book, whereon the world with wondering eyes beheld ancient Egypt speak and live.

In the interpretation of the Rosetta Stone, and through this the interpretation of the hieroglyphic inscriptions of Egypt, more than to any one else the credit is due to Champollion. This eminent Egyptologist was nine years old when the Rosetta Stone was unearthed by his countrymen, but at an early age entered upon his famous career. At seventeen he wrote a valuable paper upon the Coptic language, at nineteen he was elected Professor of History in the Lyceum of Grenoble, and when but twenty-one published his L'Egypte sous les Pharaons. In his studies upon the Rosetta Stone Champollion followed the false belief, then prevalent, in the ideographic nature of the hieroglyphs. Dr. Thomas Young, of London, who was employed in parallel studies of the same subject, made the very important discovery of the phonetic or alphabetic character of the hieroglyphs. The eager perception

of Champollion caught the suggestion, and at once putting it to the test and amplifying it until he had completed an alphabet, found true what Young had only surmised. Since, according to the old adage, which rules the scientific world, that "he only discovers who first proves," Champollion shares with Young the honor of making one of the most important discoveries of this century.

July 19, 1830, is the date of the sitting of the Academy of Sciences when the rupture between Cuvier and Geoffroy de Saint-Hilaire took place. It was a battle of giants. Although Paris was in commotion—for it was in the midst of the Revolution of July—the Academy was filled with French scientists. These life-long friends had for some years a growing difference, which from its very nature was irreconcilable, upon the comparative merits of the synthetic and the analytical methods of studying nature, and which finally resulted in the tempestuous debate in the Academy. Geoffroy, as a synthesist, maintained that organic forms are built on one plan of construction, of the same elements, of the same number, and of the same relation between organs; while, on the other hand, changed conditions varied the size and use of organs, but not the plan, and that species have undergone modifications in the change of time. Cuvier, as an analyst, could see no evidence of variability in species, and held that every organ was specially created for the purpose for which it was used. The echoes of this combat are still resounding throughout the scientific world, but with more and more unequaled result.

Geoffroy was one of Napoleon's scientific staff in Egypt, and for his firm stand, at the surrender of Alexandria, in resisting the claims of the English general to the rich collection, was honored upon his return with decorations by the emperor, and an election to the Academy of Sciences. In 1795 Geoffroy was put in correspondence with a youth in Normandy, who was devoting himself to natural history, and was so impressed with the originality of the young man's manuscripts that he invited him to Paris with the rather enthusiastic, but, as it proved, prophetic words, "Venez jouer parmi nous le rôle de Linné, d'un autre législature de l'histoire naturelle."

Georges Cuvier, to whom these words were addressed, came to Paris, entered Geoffroy's household, and wrote with Geoffroy many joint papers. It is to the credit of both men that the life-long friendship, which was for a time broken by the debate of 1830, was renewed and continued to death.

The undoubted genius of Cuvier was early recognized; for when, in 1795, the Institute was reorganized, he was elected a member of the Section on Zoölogy. This confidence was well founded, for his work was truly epochal, and to this day the

name of Cuvier stands pre-eminent in the zoölogical world. His method of classification in zoölogy was revolutionary, and is still the recognized authority; his researches in comparative anatomy may be said to be creative, for not until then was it a science, and his influence upon paleontology was not less notable. Both Geoffroy and Cuvier, like most Frenchmen, took great interest in public affairs, and both filled posts of high honor and responsibility in the state.

Goethe, whose allegiance to the synthetic doctrines of Geoffroy may have biased his judgment against its great antagonist, says: "Cuvier, the great naturalist, is admirable for his power of representation and his style. No one expounds a fact better than he, but he has scarcely any philosophy. He will bring up very well informed but few profound scholars." It must be confessed that events have proved the criticism of Goethe to be true, unless we make the single exception of Milne-Edwards.

It was in the year 1852 that Léon Foucault, the distinguished physicist, conducted some experiments in Paris to prove the rotation of the earth, which for their simplicity and beauty aroused the admiration and wonder of his *confrères*. He constructed an enormous pendulum by suspending a ball by a fine wire from the dome of the Pantheon, and set it in vibration in a northerly and southerly direction. A pendulum thus started will continue to swing in the same plane for hours. By carefully marking upon the pavement the plane of swing and comparing it with that made after the lapse of several hours, it was seen that the earth had turned under it at a definite rate. This beautiful demonstration, making visible to human eyes the actual revolution of the earth upon its axis, was many times repeated, once in our own Capitol at Washington.

In 1801, the accommodations of the Louvre being no longer esteemed sufficient, the Institute was given rooms in the *Palais des Quatre Nations*, where the several academies meet successively in different rooms. Each academy governs itself and awards its own prizes, but the library and museum are held in common, and the Institute has two prizes separate from those of the academies. Each academy meets weekly, and once yearly in public, and the grand *séance* of the whole five bodies meets annually on the 15th of August.

A writer—it is but fair to say that he is an Englishman—thus compares the French Institute and the Royal Society of England: "The members of the French Institute receive a yearly stipend; the Fellows of the Royal Society pay an annual sum for the support of their institution and the advancement of science. It would be repugnant to the feelings of Englishmen to submit to the regulations of the Institute, which require official addresses, and the

names of candidates for admission into their body to be approved by the Government before the first are delivered or the second elected. The French *savants* are, it is true, ennobled and decorated by orders, which the wiser among them, in common with true philosophers of any country, regard with indifference."

THE MEXICAN MESSIAH.

By DOMINICK DALY.

THERE are few more puzzling characters to be found in the pages of history than Quetzatcoatl, the wandering stranger whom the early Mexicans adopted as the air-god of their mythology. That he was a real personage—that he was a white man from this side of the Atlantic, who lived and taught in Mexico centuries before Columbus was born—that what he taught was Christianity and Christian manners and morals—all these are plausible inferences from facts and circumstances so peculiar as to render other conclusion well-nigh impossible.

When, in 1519, Cortes and his companions landed in Mexico, they were astonished at being hailed as the realization of an ancient native tradition, which ran in this wise: Many centuries previously a white man had come across the Atlantic from the northeast, in a boat with "wings" (sails), like those of the Spanish vessels. He stayed several years in the country, and taught the Mexicans (Toltecs) a new and humane system of religion, instructed them in the principles of good government, and imparted to them a knowledge of many useful industrial arts. He loved peace, and had a horror of war. By his great wisdom and knowledge of divine things, his piety and his many personal and godlike virtues, he won the esteem and veneration of all the people, and exercised great control over them. His sojourn in Mexico was a kind of golden age. Peace, plenty, and happiness prevailed throughout the land. The Mexicans knew him as Quetzatcoatl, or the Green Serpent, the word "green" in their language being a term for a rare and precious thing. Through some malign influence Quetzatcoatl was obliged or induced to quit the country. On his way to the coast he stayed for a time at the city of Cholula, where, subsequently, a great pyramidical mound, surmounted by a temple, was erected in his honor. On the shores of the Gulf of Mexico he took leave of his followers, soothing their sorrow at his departure with the assurance that he would not forget them, and that he himself, or some one sent by him, would return at some future time to visit them. He had made for himself a vessel of serpents' skins, and in this strange contrivance he sailed

away in a northeasterly direction for his own country, the Holy Island, or Tlapallan, beyond the great ocean.

Such, in outline, was the tradition which Cortes found prevalent in Mexico on his arrival there, and powerfully influencing every inhabitant of the country. The Spaniards found that their advent was hailed as the fulfillment of the promise of Quetzatcoatl to return. The natives saw that they were white men, and bearded, like him; they had come in sailing-vessels such as the one he had used across the sea; they had clearly come from the mysterious Tlapallan; they were undoubtedly Quetzatcoatl and his brethren come, in fulfillment of ancient prophecy, to restore the period of peace and prosperity which the country had experienced for a short time many hundreds of years before.

The Spaniards made no scruple of encouraging and confirming a belief so highly favorable to their designs, and it is conceded by their writers that this belief, to a large extent, accounts for the comparative ease and marvelous rapidity with which a mere handful of men made themselves masters of a great and civilized empire and subjugated a warlike population of millions. To the last the unfortunate emperor Montezuma held to the belief that the King of Spain was Quetzatcoatl and Cortes his lieutenant and emissary under a sort of divine commission.

The Mexicans had preserved a minute and apparently an accurate description of the personal appearance and habits of Quetzatcoatl. He was a white man, advanced in years and tall in stature. His forehead was broad; he had a large beard and black hair. He is described as dressing in a long garment, over which there was a mantle marked with crosses. He was chaste and austere, temperate and abstemious, fasting frequently, and sometimes inflicting severe penances on himself, even to the drawing of blood. This is a description which was preserved for centuries in the traditions of a people who had no intercourse with or knowledge of Europe, who had never seen a white man, and who were themselves dark-skinned, with but few scanty hairs on the chin to represent a beard.

It is, therefore, difficult to suppose that this curiously accurate portraiture of Quetzatcoatl as an early European ecclesiastic was a mere invention in all its parts. Nor is it easier to understand why the early Mexicans should have been at pains to invent a Messiah so different from themselves and with such peculiar attributes. Yet, in spite of destructive wars, revolutions, and invasions; in spite of the breaking up and dispersal of tribes and nations once settled in the vast region now passing under the name of Mexico, the tradition of Quetzatcoatl, and the account of his personal peculiarities, survived among the people to the days of the Spanish invasion.

But time and change must have done much in the course of centuries to confuse the teachings of Quetzatcoatl. Notwithstanding such mutation, enough remained of them to impress the Spaniards of the sixteenth century with the belief that he must have been an early Christian missionary, as well as a native of Europe. They found that many of the religious beliefs of the Mexicans bore an unaccountable resemblance to those of Christians.

The religion of the Mexicans, as the Spaniards found it, was in truth an amazing and most unnatural combination of what appeared to be Christian beliefs and Christian virtues and morality with the bloody rites and idolatrous practices of pagan barbarians. The mystery was soon explained to the Spaniards by the Mexicans themselves. The milder part of the Mexican religion was that which Quetzatcoatl had taught to the Toltecs, a people who had ruled in Mexico some centuries before the arrival of the Spaniards. The Aztecs were in possession of power when the Spaniards came, and it was they who had introduced that part of the Mexican religion which was in such strong contrast to the religion established by Quetzatcoatl. It appeared further that the Toltec rule in the land had ceased about the middle of the eleventh century. They were a people remarkably advanced in civilization and mental and moral development. They were well versed in the arts and sciences, and their astronomical knowledge was in many respects in advance of that of Europe. They established laws and regular government in Mexico during their stay in the country, but about the year A. D. 1050 they disappeared south by a voluntary migration, the cause of which remains a mystery.

It was not until the middle of the fourteenth century that the Aztecs acquired sufficiently settled habits to enable them to found states and cities, and by that time they seem to have adopted as much of what had been left of Toltec civilization and Toltec religion as they were capable of absorbing, without, however, abandoning their own ruder ideas and propensities. Hence the incongruous mixture of civilization and barbarism, mildness and ferocity, gentleness and cruelty, refinement and brutality presented by Mexican civilization and religion to the Spaniards when they entered the country two centuries later. "Aztec civilization was made up," as Prescott says, "of incongruities, apparently irreconcilable. It blended into one the marked peculiarities of different nations, not only of the same phase of civilization, but as far removed from each other as the extremes of barbarism and refinement."

The better—that is, the Toltec—side of this mixed belief included among its chief features a recognition of the existence of a Supreme God, vested with all the attributes of the Jehovah of the Jews. He was the creator and the ruler of the universe, and the

fountain of all good. Subordinate to him were a number of minor deities, and opposed to him a father of all evil. There was a paradise for the abode of the just after death, and a place of darkness and torment for the wicked. There was an intermediate place. There had been a common mother of all men, always pictorially represented as in company with a serpent. Her name was Cioacoatl, or the serpent woman, and it was held that "by her sin came into the world." She had twin children, and in an Aztec picture preserved in the Vatican at Rome those children are represented as quarreling. The Mexicans believed in a universal deluge, from which only one family (that of Coxcox) escaped. Nevertheless, they spoke of a race of wicked giants, who had survived the flood and built a pyramid in order to reach the clouds; the gods frustrated their design by raining fire upon it. Tradition associated the great pyramid at Cholula with this event. The traditions of Cioacoatl, Coxcox, the giants, and the pyramid at Cholula are extremely like a confused acquaintance with biblical narratives.

The points of resemblance with real Christianity were too numerous and too peculiar to permit the supposition that the similarity was accidental and unreal. The only difficulty was to account for the possession of Christian knowledge by a people so remote and outlandish—or rather to trace the identity of Quetzatcoatl, the undoubted teacher of the Mexicans. Their choice lay between the devil and St. Thomas. However respectable the claims of the former, it is clear enough that St. Thomas was not Quetzatcoatl and had never been in Mexico. He was dragged in at all because the Spaniards long cherished the idea that America was a part of India, and St. Thomas was styled the Apostle of India on the authority of an ancient and pious but very doubtful tradition. The weakness of the case for St. Thomas secured a preference for the claims of the devil, and the consensus of Spanish opinion favored the idea that Quetzatcoatl was the devil himself, who, aroused by the losses which Christ had inflicted upon him in the Old World, had sought compensation in the New, and had beguiled the Mexicans into the acceptance of a blasphemous mockery of the religion of Christ more wicked and damnatory than the worst form of paganism.

Lord Kingsborough makes the suggestion that Quetzatcoatl was no other than Christ himself, and in support of this maintains that the phonetic rendering in the Mexican language of the two words "Jesus-Christ" would be as nearly as possible "Quetzat-Coatl." He does not mean to say that Christ was ever in Mexico; but his suggestion is that the Mexicans, having obtained an early knowledge of Christianity and become acquainted with the name and character of its divine founder, imagined in subsequent ages

that Christ had actually been in Mexico, and so built up the tradition of Quetzatcoatl. But this theory does not get rid of—it makes essential—the presence of a missionary in Mexico, through whom the people were instructed in the truths of Christianity, and from whom they obtained a knowledge of Christ.

It is hard to understand what it was that Quetzatcoatl taught if it was not Christianity, and equally hard to conceive what he could have been if he were not a Christian missionary. A white man, with all the peculiarities of a European, teaches to a remote and isolated pagan people *something* the remnants of which centuries afterward are found to bear an extraordinary resemblance to Christianity. The teacher himself is depicted as a perfect and exalted type of a Christian missionary, though the Mexicans could have no model to guide them in their delineation of such a character. Long, earnestly, and successfully he preached the worship of the great unseen but all-present God, and taught the Mexicans to trust in an omnipotent and benevolent Father in heaven. He preached peace and good-will among men, and "he stopped his ears when war was spoken of." He taught and encouraged the cultivation of the earth and the arts and sciences of peace and civilization. The impression he made was, indeed, so profound that the memory of his virtues and good works survived through centuries of change and trouble, and made him acceptable as a god even to the rude, intruding barbarians, who only learned of him remotely and at second hand ages after the completion of his mission. Can he, then, be an imaginary person? Could the early Mexican pagans have evolved such a character from their own fancy or created it out of pagan materials? The thing seems incredible. It would indeed be curious if the Mexicans—never having seen a white man, and wholly ignorant of European ideas and beliefs—had invented a fable of a white man sojourning among them; it would be still more curious if, in addition to this, they had invented another fable of that white man instructing them in European religion and morals. The white man without the teaching might be a possible but still a doubtful story; the teaching without a white man would be difficult to believe; but the white man and the teaching together make up a complete and consistent whole almost precluding the possibility of invention.

Three points in relation to Quetzatcoatl seem well established: (1) he was a white man from across the Atlantic; (2) he taught religion to the Mexicans; (3) the religion he taught retained to after-ages many strong and striking resemblances to Christianity. The conclusion seems unavoidable that Quetzatcoatl was a Christian missionary from Europe, who taught Christianity to the Mexicans, or Toltecs.

Accepting this as established, the possibility of fixing the European identity of Quetzatcoatl presents itself as a curious but obviously difficult question. To begin with, the era of Quetzatcoatl is not known with any precision. It has a possible range of some six and a half centuries—from before the beginning of the fourth century to the middle of the tenth century; that is, from about A. D. 400 to A. D. 1050, which is the longest time assigned to Toltec domination in Mexico. The era of Quetzatcoatl may, however, be safely confined to narrower limits. The Toltecs must have been well settled in the country before Quetzatcoatl appeared among them, and he must have left them some considerable time before their migration from Mexico. The references to Quetzatcoatl's visits to the Toltec cities prove the former, and the time which would have been required to arrange for and complete the great pyramid built at Cholula in honor of the departed Quetzatcoatl proves the latter. From a century to two centuries may be allowed at each end of the period from A. D. 400 to A. D. 1050, and it may be assumed with some degree of probability that Quetzatcoatl's visit to Mexico took place some time between (say) A. D. 500 and A. D. 900.

If attention is directed to the condition of Europe during that time, it will be found that the period from about A. D. 500 to A. D. 800 was one of great missionary activity. Before the former date the Church was doing little more than feeling its way and developing its strength in the basin of the Mediterranean, and making extensions in settled states. After the latter date the incursions and devastations of the northern barbarians paralyzed European missionary efforts. But from the beginning of the fifth to the beginning of the eighth century there was no limit to missionary enterprise, and, if ever a Christian missionary had appeared in Mexico, all the probabilities favor the theory that he must have gone there within those centuries. The era of Quetzatcoatl may therefore be narrowed to those three hundred years, and the task of tracing his identity thus simplified to some slight extent.

It may now be asked, Is it reasonable to expect that there are, or ever were, any European records of the period from A. D. 500 to A. D. 800 referring to any missionary who might have been Quetzatcoatl? It is a long time since Quetzatcoatl, whoever he was, sailed from the shores of Europe to carry the truths of Christianity into the unknown regions beyond the Atlantic, but the literary records of his assumed period are numerous and minute, and might possibly have embraced some notice of his undertaking. It seems unlikely that his enterprise would have escaped attention altogether, especially from the ecclesiastical chroniclers, who were not given to ignoring the good works of their fellow-religionists. Moreover, the mission of Quetzatcoatl was not one

which could have been launched quietly or obscurely, nor was there any reason why it should be. The contemplated voyage must have been a matter of public knowledge and comment in some locality; it could not have been attempted without preparations on some scale of magnitude; and such preparations for such a purpose must have attracted at least local attention and excited local interest. It is thus reasonable to suppose that the importance and singularity of a project to cross the Atlantic for missionary purposes would have insured some record being made of the enterprise. *A fortiori*, if the venturesome missionary ever succeeded in returning—if he ever came back to tell of his wonderful adventures—the fact would have been chronicled by his religious *confrères* and made the most of then and for the benefit of future ages. It comes, therefore, to this—accepting Quetzatcoatl as a Christian missionary from Europe, we have right and reason to expect that his singular and pious expedition would have been put upon record somewhere.

The next step in the inquiry is to search for the most likely part of Europe to have been the scene of the going forth and possible return of this missionary. The island of Tlapallan, according to the Mexican tradition, was the home whence he came and whither he sought to return. The name of the country affords no assistance, and it might not be safe to attach importance to its insular designation. But in looking for a country in western Europe—possibly an island—which from A. D. 500 to A. D. 800 *might* have sent out a missionary on a wild transatlantic expedition, one is soon struck with the possibility of Ireland being such a country. To the question, "Could Ireland have been the Tlapallan, or Holy Island, of the Mexican tradition?" an affirmative answer may readily be given, especially by any one who knows even a little of the ecclesiastical history of the country from A. D. 500 to A. D. 800. In that period no country was more forward in missionary enterprise. The Irish ecclesiastics shrunk from no adventures by land or sea, however desperate and dangerous, when the eternal salvation of heathen peoples was in question. On land they penetrated to all parts of the Continent, preaching the gospel of Christ and founding churches and religious establishments. On sea they made voyages for like purposes to the remotest known lands of the northern and western seas. They went as missionaries to all parts of the coast of northern Britain, and visited the Hebrides, the Orkneys, and the Shetland and Faro Islands. Even remote Iceland received their pious attention, and Christianity was established by them in that island long before it was taken possession of by the Norwegians in the eighth century.

Prima facie, then, Ireland has not only a good claim, but really

the best claim, to be the Tlapallan of the Mexicans. It is the most western part of Europe; it is insular, and in the earlier centuries of the Christian era was known as the "Holy Island"; between A. D. 500 and A. D. 800 it was the most active center of missionary enterprise in Europe, and its missionaries were conspicuous above all others for their daring maritime adventures. It is natural, therefore, to suspect that Ireland may have been the home of Quetzatcoatl, and, if that were so, to expect that early Irish records would contain some references to him and his extraordinary voyage. Upon this the inquiry suggests itself, Do the early Irish chronicles, which are voluminous and minute, contain anything relating to a missionary voyage across the Atlantic at all corresponding to that which Quetzatcoatl must have taken from some part of western Europe?

To one who, step by step, had arrived at this stage of the present inquiry, it was not a little startling to come across an obscure and almost forgotten record, which is, in all its main features, in most striking conformity with the Mexican legend of Quetzatcoatl. This is the curious account of the transatlantic voyage of a certain Irish ecclesiastic named St. Brendan, in the middle of the sixth century—about A. D. 550. The narrative appears to have attracted little or no attention in modern times, but it was widely diffused during the middle ages. In the Bibliothèque at Paris there are said to be no fewer than eleven MSS. of the original Latin narrative, the dates of which range from the eleventh to the fourteenth centuries. It is also stated that versions of it in old French and Romance exist in most of the public libraries of France; and in many other parts of Europe there are copies of it in Irish, Dutch, German, Italian, Spanish, and Portuguese. It is reproduced in Usher's Antiquities, and is to be found in the Cottonian collection of MSS.

This curious account of St. Brendan's voyage may be altogether a romance, as it has long been held to be; but the remarkable thing about it is the singularity of its general concurrence with the Mexican tradition of Quetzatcoatl.

St. Brendan, called the "Navigator" from his many voyages, was an Irish bishop, who in his time founded a great monastery at Clonfert on the shores of Kerry, and was the head of a confraternity, or order, of three thousand monks. The story of his transatlantic voyage is as follows: From the eminence now called, after him, Brendan Mountain, the saint had long gazed upon the Atlantic at his feet, and speculated on the perilous condition of the souls of the unconverted peoples who possibly inhabited unknown countries on the other side. At length, in the cause of Christianity, and for the glory of God, he resolved upon a missionary expedition across the ocean, although he was then well

advanced in years. With this purpose he caused a stout bark to be constructed and provisioned for a long voyage, a portion of his supplies consisting of live swine. Taking with him some trusty companions, he sailed from Trawlee Bay, at the foot of Brendan Mountain, in a southwesterly direction. The voyage lasted many weeks, during several of which the vessel was carried along by a strong current without need of help from oars or sails. In the land which he ultimately reached the saint spent seven years in instructing the people in the truths of Christianity. He then left them, promising to return at some future time. He arrived safely in Ireland, and in after-years (mindful of the promise he had made to his transatlantic converts) he embarked on a second voyage. This, however, was frustrated by contrary winds and currents, and he returned to Ireland, where he died in 578, at the ripe age of ninety-four, and in "the odor of sanctity."

It would be idle to expect a plain, matter-of-fact account of St. Brendan's voyage from the chroniclers of the sixth century. The narrative is, in fact, interwoven with several supernatural occurrences. But, eliminating these, there remains enough of apparently real incident worthy of serious attention. The whole story, as already suggested, may be a mere pious fable promulgated and accepted in a non-critical and ignorant and credulous age. If substantially true, the fact could not be verified in such an age; if a pure invention, its falsity can not now be demonstrated. All that can be said about it is that it is in wonderful agreement with what is known, or may be inferred, from the Mexican legend. The story of St. Brendan's voyage was written long before Mexico was heard of, and, if forged, it could not have been with a view to offering a plausible explanation of a singular Mexican tradition. And yet the solution which it offers of that tradition is so complete and apropos on all material points as almost to preclude the idea of accidental coincidence. In respect to epoch, personal characteristics, race, religion, direction of coming and going, the Mexican Quetzatcoatl might well have been the Irish saint. Both were white men, both were advanced in years, both crossed the Atlantic from the same direction of Europe, both preached Christianity and Christian practices, both returned across the Atlantic to an insular home or Holy Island, both promised to come back, and failed in doing so. These are certainly remarkable coincidences, if accidental.

The date of St. Brendan's voyage—the middle of the sixth century—is conveniently within the limits which probability would assign to the period of Quetzatcoatl's sojourn in Mexico, namely, from about the fifth to the eighth centuries. The possibility of making a voyage in such an age from the western shores of Europe to Mexico is proved by the fact that the voyage was made

by Quetzatcoatl, whatever part of Europe he may have belonged to. The probability of St. Brendan designing such a voyage is supported alike by the renown of the saint as a "navigator," and by the known maritime enterprises and enthusiastic missionary spirit of the Irish of his time; the supposition that he succeeded in his design is countenanced by the ample preparations he is said to have made for the voyage.

There is a disagreement between the Mexican tradition and the Irish narrative in respect to the stay of the white man in Mexico. Quetzatcoatl is said to have remained twenty years in the country, but only seven years—seven Easters—are assigned to the absence of St. Brendan from his monastery. Either period would probably suffice for laying the foundations of the Christianity the remnants of which the Spaniards found in the beginning of the sixteenth century. On this point the Irish record is more likely to be correct. The Mexican tradition was already very ancient when the Spaniards became acquainted with it—as ancient as the sway of the vanquished Toltecs. For centuries it had been handed down from generation to generation, and not always through generations of the same people. It is, therefore, conceivable that it may have undergone variations in some minor particulars, and that a stay of seven years became exaggerated into one of twenty. The discrepancy is not a serious one, and is in no sense a touchstone of the soundness of the theory that Quetzatcoatl and St. Brendan may have been one and the same person.

A curious feature of the Mexican tradition is its apparently needless insistency upon the point that Quetzatcoatl sailed away from Mexico in a vessel of serpents' skins. There seems no special reason for attributing this extraordinary mode of navigation to him. If the design were to enhance his supernatural attributes, some more strikingly miraculous mode of exit could easily have been invented. The first impulse, accordingly, is to reject this part of the tradition as hopelessly inexplicable—as possibly allegorical in some obscure way, or as originating in a misnomer, or in the mistranslation of an ancient term. But further consideration suggests the possibility of there being more truth in the "serpents' skins" than appears at first sight. In the absence of large quadrupeds in their country the ancient Mexicans made use of serpents' skins as a substitute for hides. The great drums on the top of their temple-crowned pyramids were, Cortes states, made of the skins of a large species of serpent, and when beaten for alarm could be heard for miles around. It may, therefore, be that Quetzatcoatl, in preparing for his return voyage across the Atlantic, made use of this material to cover the hull of his vessel and render it water-tight. The Mexicans were not boat-builders, and were unacquainted with the use of tar or pitch, employing

only canoes dug out of the solid timber. When Cortes was building the brigantines with which he attacked the city of Mexico from the lake, he had to manufacture the tar he required from such suitable trees as he could find. Quetzatcoatl may have used serpents' skins for a similar purpose, and such use would imply that the vessel in which he sailed away was not a mere canoe, but a built-up boat. If he was really St. Brendan, nothing is more likely than that he should seek for a substitute for tar or pitch in skins of some sort. Coming from the west coast of Ireland, he would be familiar with the native curracles, coracles, or hide-covered boats then in common use (and not yet wholly discarded) for coasting purposes, and sometimes for voyages to the coasts of Britain and the continent of Europe. Some of these were of large size, and capable of carrying a small mast, the body being a stout framework of ash ribs, covered with hides of oxen, sometimes of threefold thickness. It may have been a vessel of this kind which Quetzatcoatl constructed for his return voyage, or it may be that he employed the serpents' skins for the protection of the seams of his built-up boat in lieu of tar or pitch. In any case the tradition makes him out a navigator and boat-builder of some experience, and if he were really St. Brendan he would have had a knowledge of the Irish mode of constructing and navigating sea-going crafts, and would probably have employed serpents' skins, the best Mexican substitute for ox-hide, in either of the ways suggested.

In the Mexican tradition there is no certain reference to Quetzatcoatl having with him companions of his own country, though in the story of St. Brendan the Irish saint is given such companions both in his going out and coming back. But the Mexican tradition nowhere negatives, either by implication or directly, that Quetzatcoatl had companions of his own race, and it seems in the highest degree improbable that he could have crossed the Atlantic both ways alone and unassisted by comrades. It may, therefore, be supposed that the fact of Quetzatcoatl having attendants of the same religion and nationality as himself was a detail omitted from an account which chiefly concerned itself with the great figure of Quetzatcoatl himself.

It would be presumptuous to claim that the identity of Quetzatcoatl with St. Brendan has been completely established in this essay, but it may reasonably be submitted that there is no violent inconsistency involved in the theory herein advanced, and an examination of the evidence upon which it is based discloses many remarkable coincidences in favor of the opinion that the Mexican Messiah *may* have been the Irish saint. Beyond this it would not be safe to go, and it is not probable that future discoveries will enable the identity of Quetzatcoatl to be more clearly traced.—*Gentleman's Magazine.*

THE EDUCATION OF CHILDREN.

IN studying the plans laid down by Friedrich Froebel for the education of young children, one is reminded of a passage in his letter to Krause, where he says:

> Here there budded and opened to my soul one lovely bright spring morning, when I was surrounded by Nature at her loveliest and freshest, this thought, as it were by inspiration: That there must exist somewhere some beautifully simple and certain way of freeing human life from contradiction, or, as I then spake out my thought in words, some means of restoring to man himself at peace internally; and that to seek out this way should be the vocation of my life.

Froebel in his own childhood had suffered much from this contradiction in life. He had a severe father and an unsympathetic step-mother; and had himself felt the ill effects of a stern and rigid rule, which merely required conformity to the given law without inquiring if conformity were possible. He had found this kind of rule a hindrance to true development, inasmuch as organic growth can not take place according to rules prescribed from without, but only according to the natural law. Gradually the idea took shape in his mind that this contradiction was not a necessary condition of life, that the soul and the outer world are not meant to be forever at war, that when we have learned to live aright this conflict will cease and they will be at one.

The idea of the introduction of harmony into education and into life seems to be the keynote of all Froebel's teaching. At the time that the thought above quoted from the letter of Krause first came to him he had not as yet realized that this harmony might be effected by a change in education; he came gradually to see that the object for which he was striving was the substitution of development for repression and arbitrary rule. He says again in the same letter:

> My experience, especially that gained by repeated residences at the university, had taught me beyond a doubt that the method of education hitherto in use—especially where it involved learning by rote, and where it looked at subjects simply from the outside or historically, and considered them capable of apprehension by mere exercise-work—dulled the edge of all high true attainment, of all real mental insight, of all genuine progress in scientific culture, of self-contemplation, and thus of all real knowledge and of the acquisition of truth through knowledge. I might almost go further and say that its tendency was toward rendering all these worthy objects impossible. Therefore I was firmly convinced, as of course I still am, that the whole former educational system, even that which had received improvement, ought to be exactly reversed and regarded from a diametrically opposite point of view—namely, that of a system of development.

The principles of Froebel, when rightly understood, are not only a guide enabling us to form natural systems of education,

but also a far-reaching criticism of life in general, teaching as they do that the ideal life is not one in which there is constant strife between the soul and the outer world, but one in which these are in harmony; that we must not waste our energies in striving to perform the impossible, but must rather work out our best impulses with integrity and without affectation. But while Froebel's principles are in theory equally applicable to the conduct of life and to methods of education, they are practically more easily applied to the latter, for the outer world in which our children live is less complicated and more easily regulated and arranged. We can not provide them with an ideal world, but we can do much more for them toward this object than we can for ourselves. Let it not be said that they will thus be unfitted for life in the world as it is. Rather will they be strengthened and enabled to take their places rightly therein—enabled also each in his own sphere and according to his strength to exert the right kind of influence upon the outer world and help on progress in the right direction.

A well-regulated *Kindergarten* is an example on a small scale of what life in the outer world ought to be. Each individual is encouraged to exercise choice in all cases where it is not hurtful to the community, and no one is compelled to do disagreeable things for the sake of what is so often falsely called discipline. The children are not asked if they are good or told that they are bad. They are not encouraged to think about themselves at all, but the moral feelings are unconsciously developed because there is an atmosphere of sympathy and happiness. Fear, the most common cause of untruthfulness in children, is entirely removed, and the nature of the surroundings is such as to gradually diminish other causes, such as boastfulness and selfishness. The teacher watches the children and makes use of their own natural tendencies to further the objects which he has in view. He works with them, constantly helping and encouraging, gently turning their efforts in the right direction, and never takes up the position of a cold and rigid martinet. A child who does not succeed in anything he is trying to do is not punished and generally not blamed; but the children are not idle, because they are interested in their work, and because success is always preferable to failure. On the moral as well as on the intellectual side, the teacher does not make demands upon the powers of the children which are not likely to be satisfied. Right action in this matter requires sympathy, judgment, and experience. It is hurtful to the moral nature to be asked to perform a good action of which that nature is not yet capable, but it is by the performance of that which is within its powers that the moral nature is strengthened and developed. Thus the child learns by doing, and moral progress becomes a

steady development instead of a constant struggle between duty and inclination. This is the only way of reaching that absence of effort which is as necessary to a harmonious life as it is to a work of art. It also tends to produce in every individual a certain true simplicity of nature, which in a sense makes every one a genius by freeing him from the bondage of a dull conventionalism.

The same principles apply on the intellectual side of development. One must not set up an arbitrary standard before the child and crudely expect him to attain to that. In short, we must find something which he can do, and not peremptorily order him to perform things which are impossible to him. What is the right cure for idleness? First of all it may be safely stated that punishment is *not* the cure. Idleness is generally a sign either that the work is too difficult or that it is unsuited to the child. Very few children will prefer doing nothing to suitable occupation; and those few are in an unhealthy condition, probably caused by previous mismanagement. A head master remarked not long ago in a speech on prize-day that he had often seen an apparently dull boy changed into a bright, happy one, by being set to practical work in the laboratory. When children are dull, it is the business of the persons who are educating them to find out why they are dull, and apply the right remedy. The children can not find it out for themselves, any more than they can discover the causes and cures of their bodily ailments. They often have a vague sense that they are not being treated fairly, and in some cases they even learn to regard teachers as their natural enemies.

The fact is, that not only is teaching useless when it fails to arouse interest, but it is injurious to the moral nature as well as to the mind. An ignorant boy is a less unsatisfactory object than one crammed with undigested information. One does not know how to begin to improve the latter; he seems a hopeless case; he is persuaded that all school-books are unutterably dull, and never opens one if he can avoid doing so. When this state of mind is once produced it is difficult to alter it. Probably it can only be altered by giving up school-books entirely for many months, and putting the boy to some totally new occupation. But it is by no means an impossible task to prevent its being produced at all. In a *Kindergarten* a child's mind never gets into this state. There is a steady development which should be continued throughout the period of education. The pressure of contradictions—which is incompatible with real moral and intellectual progress—should never be introduced.

One of the problems of the present time is the successful application of Froebel's principles to the education of children beyond the age for the *Kindergarten*. Owing to the fact that the attention of teachers has been more frequently directed to the

practical working out of Froebel's principles so far as young children are concerned than to the general principles themselves and their application to the training of older children, we have not yet a good system of training for children too old for the *Kindergarten* and too young for the grammar school. In many *Kindergartens* there are classes for children who have reached this stage, and an attempt is made to carry on the system; but the teaching is apt to be a little too childish, to fail in rousing fresh interests and not to develop sufficiently the energies of the children. Yet it appears to be less injurious than that often given to children between seven and fourteen years old in the junior classes of grammar schools and high schools, where tasks are too often set which are beyond the powers of the children, or fail to arouse their interest, in some cases even producing a feeling of positive disgust toward all kinds of school-work. A few months of such teaching often destroys the effect of years of careful and wholesome training. The child learns nothing which is of any real value, and his whole moral nature is strained and irritated. Perhaps fear of the teacher is added to the other difficulties of the case—and yet it would not be fair to blame him too severely. It is difficult for masters who are inexperienced in teaching, and fresh from the university, to understand and sympathize with the requirements of minds at a stage of development so different from their own. In many cases they are doing their work as well as they know how to do it; but they have undertaken a difficult task, and often have no idea of the care which is needed to perform it rightly. True sympathy with children is chiefly found in the young who can remember their own childhood distinctly, and in those who are old enough to have the feelings of a parent toward them. A few men, and more women, have it throughout life. It would not be possible, however, to select a person less likely to have sympathy with a child than a man between the age of twenty and twenty-four, who has lately been giving all his attention to the development of his own mind. As this is the kind of teacher boys under twelve years old generally have in grammar schools, the result is naturally not satisfactory. But the fault is more in the system than in the individual teacher.

It is not yet generally recognized that the younger a child is, the more important is the training which he receives. Froebel realized this fully, and wisely applied himself to working out in detail a good system of training for very young children. In our time a system of wholesome training for children between seven and fourteen is still urgently needed. It is beyond the scope of the present paper to enter into detail as to what this training must or must not be. But some points may be mentioned. (1) There must be the regular performance of some kind of useful work

suited to the age and capacity of the child. (2) Book-learning must be given up in the case of any child to whom it can not be made pleasurable. (3) Prizes must not be given for success in school-work, nor punishment for failure. (4) The natural love that children have for games must be taken advantage of, so as to cause a healthy development of the moral nature, the physical powers, the imagination, etc. (5) The energies of the child must be fully as well as harmoniously developed, and the child's growth must not be stunted by too easy work. (6) A love of nature and of all forms of beauty must be stimulated and encouraged.

The difficulty of establishing a natural system of education is much increased by the anxiety on the part of parents to see at every point evidence of their children's progress. This natural but inconvenient wish has prevented the *Kindergarten* system from coming more generally into use, and unless parents can be induced to place more confidence in the capacity and judgment of teachers, it is to be feared that it will also prevent the introduction of improved systems of training for older children. In inspecting schools for young children an examiner should make it his business to find out whether they are being taught in the right way, not whether they have reached a high standard of book-knowledge. The latter is of little or no importance, the former is all-important. We should not hear so many protests against examinations if examiners knew how to do their work rightly. At present examiners think it is their business to find out what the children know, and so long as that is the case examinations will not be satisfactory. Are the children's minds in a healthy state and are their faculties being drawn out in the right way? These are the questions that need attention. An examination should be so conducted as to avoid developing self-consciousness and other morbid tendencies. We want to teach the children to be, not to seem. More freedom is needed both for teachers and children. Perhaps it may not be thought safe to grant the freedom; that has often been the case in history, and yet the grant of freedom has been generally justified by its results.

Frequent examinations prevent natural growth. We do not expect our gardeners to show us the roots of their growing plants. A child's attention should be fixed if possible more on the subject of study itself than on his own progress in it, and examinations as they are now conducted are apt to prevent this. They are less injurious to older children when an interest in the subjects themselves has been firmly established. But all examinations tend to encourage the performance of work in order to show what one can do, which is not a good motive for human conduct. It is wholesome to work from interest in a subject, or in order to help others, but not in order to show that we can do well, still less

that we can do better than others. An object of this kind tends to destroy that "harmony of life," that "peacefulness of heart," the attainment of which for himself and others was Froebel's chief object. In our time, when the conflict of life seems to be constantly increasing, this harmony and peacefulness seem to be further off than ever. It is more difficult to introduce harmony into complicated than into simple forms of life. We have had many writers of pretty ballads, but only one Shakespeare. In past generations there were many people who lived harmonious but narrow lives, the men pursuing the same occupations which their fathers pursued before them, and the women chiefly occupied with household concerns, thus quietly passing through a life of calm content without hurry or striving. Many of them worked out in their lives the saying that "to do is better than to know," though perhaps if they had heard it they would hardly have understood it. But this kind of life has become impossible, and the problem now is how to introduce unity into the turmoil of modern life.

Like Froebel, when a problem of the same kind presented itself to him, we turn to a change in education for its solution. Much may be done by training children to value things in their right proportions from the first, and by encouraging them to preserve the simplicity and reality of childhood, instead of exchanging them for the shams and conventions of "grown-up-land." Our faith ought not to be less than that of Froebel. It is true that the conditions are now more complicated, but on the other hand the world is now beginning to awake to the immense importance of right education. We are now taking pains to find out what is really wanted in the lives of the poor, instead of trying to force upon them things which we think they ought to want, so that many lives, which would otherwise be very narrow, are gradually being widened in a wholesome way. It is going out of fashion to offer to people, because they are poor, mental and moral food which the givers would decline if offered to themselves. In short, there is more reality than at any former period in the efforts of the rich to help the poor, and an earnest attack is being made in this direction on the contradictions of life. There are many among the rich who are painfully oppressed by the weight of luxuries, which it appears impossible under present conditions to share with others, and are making earnest endeavors to find out the right kind of mercy which shall really bless him that gives and him that takes. It is found that something can be done by offering opportunities for culture, for innocent enjoyment, for participation in simple pleasures, and, to those who are capable of it, for deeper thought. So that here also we find in wholesome education a lessening of the contradictions of life.

And just as a thoughtful teacher learns nearly as much from his pupils as they learn from him, so do those who are engaged in widening the lives of the poor find themselves refreshed and strengthened by the wholesome simplicity, practical common sense, and steady patience which are so often found among those who spend their lives in hard manual toil. Steady work teaches many lessons which can not be learned in any other way, and when it does not absorb the whole nature, and is such that the worker can take pleasure in it—it is wholesome training. So much is this the case that perhaps what is most needed just now for the children of those who are not poor is this same manual work, if only for a short time every day. In this would be found a cure for many of the nervous diseases which are so common. It would give some knowledge of the nature of the objects with which we are surrounded, and the right feeling of respect for labor which it is difficult to give in any other way. It would develop the physical powers and the natural tendency which children have to help others, a tendency which is very insufficiently developed at present. The work must be useful—one kind of useful work being of course the production of beautiful things—or it will fail in its chief object. The child must not think it is done entirely for his sole benefit, and therefore it must not be done solely for that purpose, as it is no part of sound education to deceive a child for his supposed good.

In a well-conducted *Kindergarten* the childen do work which fulfills these conditions so far as it is possible to do so at their age. The right kind of beginning is made. As they get older they should learn to do harder work and work of a more practical kind, and also continue the endeavor to produce beautiful things. There is no kind of useful work which can not be made a pleasure to the worker if set about in the right way. Froebel, in writing of his childhood, mentions the advantage he received from helping his father and mother in gardening and in household occupations.

As in intellectual work, it is very important not to make too large demands at first upon the powers of the child. The development of his powers must be gradual and will then be pleasurable. If a feeling of despair is allowed to arise, progress becomes impossible until the happiness of the child is restored by encouragement. Pleasure and trust in the teacher are necessary conditions of development. Nothing satisfactory can be accomplished by a teacher without close sympathy with and love for the child. An attempt to further the development of a human being by harsh rule and stern command, with threats of punishment, is like pulling the branches of a tree to make them grow. If the tree be firm and strong, no effect is produced beyond some slight damage to the branches; but if the tree be young and tender, its delicate

roots are bruised and broken. Growth does not come by force. The right conditions must be supplied, the right food offered, and then the growth will take place naturally and freely. It is most true, as Froebel points out, that plant-life teaches many lessons about education.

In child-nature there is an infinite variety, and sympathy with the special needs of each individual is necessary for right development. We want to lighten somewhat the pressure of custom which lies upon us with a weight

"Heavy as frost and deep almost as life,"

and to bring out in every child something of that fresh originality of mind which, when it is found, makes even ignorant persons agreeable companions and useful members of society, and which is also the first condition of brilliant success in all work.

Nature is a great healer and sets many crooked things straight. A child's mind, when working under reasonably free conditions, seizes upon that which it requires and disregards that which is unnecessary or hurtful. There is some tendency on the part of teachers in the *Kindergarten* not to realize this quite sufficiently, and consequently to make their system a little too artificial. It is not satisfactory to bind one's self down too rigidly to one method however good. The laws of mental development are at present very imperfectly understood. Growth often takes place in unexpected ways, or does not take place when we should expect it. The order of development is less rigid and more variable than is sometimes supposed. If this were not the case, there would be more difference than there is at present between a child educated in a *Kindergarten*, and one educated in a well-ordered home. In the home the objects present themselves to the child without any fixed order—he tumbles into knowledge; and this want of system is not without its advantages, seeing that we can not make our systems perfect. Even if a definite system be pursued, some time and opportunity must be given at all stages of education for this chance development. In a home where a child is allowed, under the care of some educated person, to investigate the objects around him and the natural and artificial processes which are conducted in the house and its surroundings, much healthy development may take place without any fixed system. But a life which is limited to the nursery with artificial playthings and a daily walk by the side of a perambulator is eminently unsatisfactory. An ignorant nurse has no idea of the kind of sympathy and help a child requires. Even when she is fond of him she interrupts the workings of his mind with rude laughter. She does not understand how to speak the truth, though if convenient she will stigmatize an unintentional misstatement as a lie. She will capriciously surround him with vexatious restric-

tions, yet will develop self-consciousness and selfishness by flattery and over-indulgence. This is not a promising state of things; but a determined child, especially if he be fortunate enough to have brothers and sisters, will modify it somewhat by engaging in active and healthy play whenever he can elude the vigilance of his nurse, who is full of anxiety about the state of his clothes, and disapproves of most kinds of games. In a house where a reasonable amount of freedom is allowed, and where the children are intelligent and active in mind and body, they will, unaided by their elders, carry on their development by means of games in a fairly satisfactory manner. This part of education is, however, better managed in a *Kindergarten* than anywhere else. Opposing tendencies are woven into harmony by the experienced teacher, suggestions are made when required, and the needs of all the children are duly considered. Every child takes part according to his ability, and no one is forgotten or neglected. The children are perfectly happy, because they are not indulged too much or overexcited, and the performance is as different from the proceedings at an ordinary children's party as Milton's "heart-easing mirth" from his "vain deluding joys."

We owe to Froebel the first recognition of the high purpose in children's play, and the idea of ordering and arranging it so as to form a harmonious development according to Nature's methods. Full of sympathy with child-nature, and having himself a child-like simplicity of mind, he saw that true education is not the suppression of natural tendencies, but their wholesome encouragement. The outside life of the world has many inharmonious elements. In these children's games we have a little image of the world with the inharmonious elements eliminated. Joining in them is a training for living the right kind of life. The children do not talk about living rightly, but they do it. This is the best preparation for the right use of a wider experience.

A teacher of ethics better known than Froebel taught that the first condition of right life was to "become as a little child."

NOTE.—In quoting from Froebel's letter to Krause, the English translation by Emilie Michaelis and H. Keatley Moore has been used.

—*Macmillan's Magazine.*

A CURIOUS series of coincidences is noticed in Dr. S. T. Hickson's Naturalist in North Celebes. The island is a frontier point between Malaysia and Melanesia, and is situated linguistically almost where the Papuan, Melanesian, and Malayan families of speech meet. It is further, at the same time, the home of a marsupial sloth, the *Cuscus celebensis*, which has the characteristics of the Australian fauna, and of a tailless baboon, the *Cynopithecus nigrescens*, African in its character. Thus the two most conspicuous mammals represent widely distinct zoölogical provinces. The marsupials there reach their northern and the *Cynopithecus* its southern limit.

SKETCH OF NIELS H. C. HOFFMEYER.

TO Captain Niels Hoffmeyer meteorology owes some of its most important developments, and particularly the organization of what may be called the first ocean weather service.

NIELS HENRIK CORDULUS HOFFMEYER was born in Copenhagen, Denmark, June 3, 1836, the son of Colonel A. B. Hoffmeyer, and died in Copenhagen, February 16, 1884. It was at first intended that he should pursue a professional career, and his studies were begun with a view to that end; but the plan of his education was changed and he was sent to the military academy. He became an officer when eighteen years old, and was given an appointment in the artillery service when his course had been completed. His military effectiveness was impaired by a disposition to rheumatic fever, from which he had suffered in early youth, so that after having been engaged in the Schleswig-Holstein War he was prostrated again in February, 1864; and when the army was reduced at the close of that year he was placed on the retired list. Having spent a few months after his recovery in recruiting at the baths, in 1865 he visited France and spent a year in studying the methods and operations of the iron-foundries at Paris and Nantes. Returning to Denmark, he busied himself in furthering the establishment of similar works at Christiansholm, and while thus engaged was appointed to a post in the War Department and to be a captain of militia in Copenhagen.

His sojourn in France was contemporaneous with Leverrier's activity in meteorological research and experiments, under the impulse of which the principles that distinguish the modern methods in that science were largely developed. The publication of this student's daily weather map of all Europe in the *Bulletin International* had been begun only two years before. Hoffmeyer's attention was directed to the subject, and he entered into the study of it with an ardor that greatly redounded to the gain of science. He carried his newly aroused enthusiasm in this work into his war office, where he continued his studies; and when the Meteorological Institute was established in 1872 he was made its director. "There could scarcely be a more fortunate appointment," says Nature, to whose various articles we are chiefly indebted for the materials of this sketch, "for Hoffmeyer was gifted not only with unusual energy, but also with a very pleasant manner, so that he made friends for the new office and for its work wherever he went."

"It was from a singularly clear and firm apprehension of the characteristics of modern meteorology," Nature says in another article, "and an unflinching application of them to the facts of

observation, that Captain Hoffmeyer has left his mark on the science—these principles being the relations of winds, temperature, and rainfall to the distribution of atmospheric pressure. In working out the weather problem of Europe, no country occupies a more splendid position for the observation of the required data than does Denmark with its dependencies of Faroe, Iceland, and Greenland. Denmark was slow to occupy the field, nothing having been done by the Danish Government prior to Hoffmeyer's appointment as Director of the Meteorological Institute. In a short time these important regions were represented by stations in Greenland, Iceland, and Faroe. The meteorology of Denmark proper was pushed forward with great vigor."

Of this work Mr. E. Ersley said, in an address to the Danish Geographical Society on the occasion of Hoffmeyer's death: "Hoffmeyer saw very early and clearly that our little country was of great importance in meteorology; for it lies between two seas, the North Sea and the Baltic, and exhibits a peculiar division of land and water, while storms sometimes originate in its precincts. For that reason we ought to endeavor to establish as many observing stations as possible. His efforts to accomplish this were embarrassed by the scantiness of the means allowed the Institute. But his practical sense came to his help, and he engaged a large number of private persons to erect stations where daily observations might be taken—at most of them without pay, and also at many without instruments except such as were privately furnished. In this way our country has been planted with not less than two hundred minor meteorological stations. He also saw that our further possessions, which were as good as unknown meteorologically, might be made members of extreme importance in the series of weather observations. He therefore secured meteorological stations in them—six in the Faroes, twenty-three in Iceland, and fourteen in Greenland, besides using his persuasive conversational powers to induce many ship-captains to take instruments on their voyages, especially on those to Iceland and Greenland."

Hoffmeyer labored at the Institute twelve years uninterruptedly for the advancement of meteorology, and, although suffering much in his later years from the effects of his rheumatic fever on his heart, with irrepressible energy.

In 1873 Hoffmeyer began the publication of the monthly Meteorological Bulletin of the North, and shortly afterward the issue of a daily meteorological chart for his own country, Norway, Sweden, and northwest Russia. To this chart was added an explanation for the use of subscribers. The work was found valuable by English meteorologists, because it supplemented their own daily weather charts and those of the *Bulletin International*,

for a district extending from 63° east to 60° west longitude, and from 30° to 75° north latitude, whence accurate information was seldom obtainable by telegraph in western Europe. Although these charts did not at first repay the outlay made upon them, they were so well received by the meteorologists of Europe as to encourage their continuance. Their scope was enlarged in 1875, in accordance with the advice of the directors of various central institutions, so as to embrace a more considerable part of the globe, and give some idea of the distribution of temperature. Mercator's projection was discarded, in order to avoid the exaggerations of dimensions in northern regions; and other improvements in detail were made. These synoptical charts, giving observations made three times a day in Denmark, Faroe, Iceland, and Greenland, were continued for more than three years, or till November, 1876, at Captain Hoffmeyer's personal expense. Arrangements had been made in the summer of 1883 to resume the publication, in conjunction with Neumayer, and the first sheets of the new series were printed on the day after that of Hoffmeyer's death.

Captain Hoffmeyer was a worker in meteorology rather than a writer of papers and books on the subject. The service that he did is best seen in the organization of a system of stations at intervals across the ocean wherever his country had jurisdiction; in the conception of his synoptical charts; in the regular publication of the Meteorological Bulletin of Denmark, described in Nature as in several respects among the best that reached it; and in his co-operation in the formation and movement of the International Meteorological Congress. He was one of the secretaries of the meeting at Rome in 1876; and was a member, appointed by the Vienna Congress of 1873, and a secretary of the Conference for Maritime Meteorology that met in London in 1874. He also made some valuable literary contributions to the science. Among these are his papers on the Greenland Foehn, 1877, and on the distribution of atmospheric pressure in winter over the North Atlantic, and its influence on the climate of Europe, 1878. The former of the papers related to the sudden changes of temperature which mark the winter climate of Greenland, under which the mean temperatures of that season sometimes vary almost as much as 23° C. in different years, and Upernavik is sometimes as warm during the darkness of the polar night as the south of France. Sudden and sharp changes often occur several times in the course of the same month; and the rises always stand in connection with a veering of the wind to southeast and east. The phenomenon of a warm wind blowing from an interior which is covered with snow and ice has then to be accounted for. The older authors, to explain the paradox, re-

sorted to imaginary volcanoes in action, or to the hypothesis of a comparatively mild climate in the interior—which it would be impossible to sustain on meteorological grounds; for the interior of every continent must necessarily be colder, by the effect of radiation, than the coast, where the sea is an ameliorating factor. Another attempted explanation depended on the Gulf Stream, whence the southeast winds were supposed to blow warm; but this, though reasonable, was insufficient.

When Hoffmeyer's attention was directed to these facts, his thoughts turned to other regions of the earth, and finally to the Foehn of the northern slopes of the Alps, where "a stormy southerly wind sometimes begins to blow very suddenly, which, from the snow-covered summits, hurls itself with irresistible force through the valleys which lead toward the north, and throws the Alpine lakes into frightful commotion. This wind, which is named Foehn, has, although it comes from a snowy region, an unusual warmth and dryness." At the same time that the southerly wind is found as an unusually warm and dry Foehn on the northern side of the Alps, a humid sirocco, generally accompanied by an enormous fall of snow, is blowing on the southern slopes of the mountains. This phenomenon had been accounted for by Dr. Hann, of Vienna, as the effect of the condensation, coming down from the tops of the mountains, of the air which had been cooled and deprived of its moisture by precipitation, in ascending the opposite slopes. Dr. Hann's calculations showed that the temperature of a south wind, lowered half a degree for every hundred metres of ascent, was raised one degree for every hundred metres of descent. These phenomena repeat themselves in Greenland. The author sketched in detail a Foehn period which lasted from eighteen to twenty days in the end of November and beginning of December, 1875, when Jakobshavn was for eight days warmer than north Italy. Unfortunately, direct observations from the uninhabited east coast of Greenland and the nearest parts of the Atlantic were wanting; but it was possible to show that during the same period a strong southeast wind blew from the sea over the land; for, according to the Buys Ballot law, the wind always blows so that it has the greater pressure of the atmosphere on its right, and, the more unequally the pressure is distributed, the greater is the velocity of the wind. Just during the eight days of heat at Jakobshavn, the barometer was much higher in Iceland than at Davis Strait. Over the tract lying between these places there had thus prevailed a strong southeast wind.

In the other paper, which is declared to be "an original and highly important contribution to science, whether regard be had to the method of investigation or to the results," Hoffmeyer showed that Greenland and Iceland exert a powerful influence

on the distribution of atmospheric pressure not hitherto properly recognized, resulting in the mean minimum of pressure being localized distinctly in the south of Iceland—a minimum accompanied by two subordinate minima, one in Davis Strait and the other in the Arctic Ocean, midway between Jan Mayen and the Lofoden Islands. It was made plain, from typical charts giving the mean of four winter months, that one or the other of these minima plays the chief part, the other two being, for the time, subordinate; and that, according as one or the other of the minima predominates, so is the character determined, as regards mildness or severity, of the weather of the winter of the regions surrounding the north Atlantic.

An illustration of his method of working is afforded by the explanation he published of the causes of the cold weather that prevailed over Europe in May, 1874. He showed that a maximum of pressure had prevailed over northwestern and western Europe, "stretching like a great screen" between the Atlantic and central Europe, from Spitzbergen almost to Algiers, while the minimum came partly from the arctic seas, and partly from the western Mediterranean, with gradients steep toward the north and west. Such a distribution of pressure must give rise to a cold polar stream flowing over the greater part of Europe. In Vienna the cold was greatest between the 16th and the 18th, and then the high pressure began to travel eastward, with the production of a great change, so that soon the pressure was lowest in the very district where a few days before the maximum had existed; and the temperature rose. A similar cycle of phenomena occurred in the next month. The author observed in this paper that areas of high pressure are much more quiet and longer lasting than minima, which travel rapidly, change their shapes, and throw off secondary disturbances.

The Meteorological Bulletin had become by the time of Hoffmeyer's death a very important and complete publication. In January, 1884, the number contained pressure results for thirteen stations, temperature for one hundred and nine stations, and rainfalls and other forms of precipitation for one hundred and fifty-nine stations; and these results were graphically shown on four maps, accompanied with a full descriptive letterpress—one map giving the isobars for the month, another the isothermals, and on the same map the mean temperature of each of the one hundred and nine stations; a third map, the miminum temperature at each of the stations; while the fourth map gave isohyetal lines, showing the rainfall, with the amount at each of the one hundred and fifty-nine stations entered in plain figures.

The most important results deduced by Hoffmeyer from his maps were contained in his pamphlet, *Étude sur les Tempêtes de*

l'Atlantique Septentrional et project d'un Service Télégraphique International relatif à cet Océan, Copenhagen, 1880 (Study of the Storms of the Northern Atlantic, and Project for an International Telegraphic Service relative to that Ocean); "and up to the very last," says Nature, "he never ceased to use his utmost efforts for the establishment of a meteorological telegraphic service with America, *via* the Faroes and Iceland."

Besides enjoying the honors and positions already named, Hoffmeyer was Secretary of the International Polar Commission; an honorary member of the Royal Meteorological Society of London; and Danish Commissioner to the Fisheries Exhibition, in London, in the summer of 1883. While performing the duties of the last position, he complained of great weakness of the heart. He had suffered from occasional attacks of rheumatic fever; was ill for some time in December of the same year; and was finally attacked in January, 1884. He continued to work at the duties of his position, whenever he was able, till the last. His biographer, in Nature, says that, "to all who knew him, the memory of his eager readiness to assist fellow-workers, the urbanity of his manner, his joyous nature, and the unusual warmth of his friendship, can not but awaken the keenest feelings of regret for his early death."

DR. J. WALTER FEWKES exhibited to the National Academy of Sciences, at its recent meeting in New York, specimen reproductions of Indian sounds and music obtained by means of the phonograph. Some of the Indian languages are becoming extinct; the sounds of some can not be satisfactorily represented by any system of transliteration. The phonograph affords the only good means of preserving these. Cylinders were displayed containing records which the author had obtained last summer among the Passamaquoddy Indians of Maine and the Zuñis of New Mexico. From the former he had got sacred songs, religious rituals, folk-lore, and counting-out rhymes. Many of these will perish with this generation, for they are known to a few only of the older men. From the Zuñis he obtained in the phonograph their ancient religious rituals and formulas, their prayers, their songs at the corn-dance and other festivals, and their war-cry, which were reproduced for the benefit of the Academy. A difference was noticeable in the reproduction of the songs of the Passamaquoddys and of the Zuñis. Major Powell and Prof. E. S. Morse were of the opinion that the former was the music of one who had come in contact with civilization, while the latter was that of the aboriginal savage. The difference was in the intervals. It appeared by Dr. Fewkes's statement that the Maine Indians had been to a school and had learned from some "Sisters." The scale of Indian music, like that of the Zuñis, Major Powell said, can not be reproduced on our common staff, for they have intervals of one tenth, and even one twentieth. The Zuñi music had a sort of monotonous basis, broken by a succession of sharp sounds. Sometimes the movement was rapid, sometimes it was slower, but the essential characteristic was the monotone with lugubrious and unearthly variations.

CORRESPONDENCE.

ETHICS IN THE SCHOOLS.

Editor Popular Science Monthly:

SIR: There is evidently a wide-spread dissatisfaction with the lack of moral influences in our public schools. Religious people declare that the schools are godless, and are producing a generation of atheists. An earnest and growing class think that some modification of the school work should be made that would aim at developing every pupil into the noblest type of a human being. At present, from the lowest primary class to the university diploma, there is not a single study introduced that is designed primarily for the development of any side of character. Moral philosophy, to be sure, is taught in some higher-grade schools and in all the colleges, not for the purpose of making moral men and women, but that the student may know the theories about the existence of God, his relation to men, the basis of morals, freedom of will, etc.

Among those who are not actually opposed to moral teaching, we may recognize four groups, each occupying a different attitude toward this matter—the indifferent, the Roman Catholic Church, the Protestant Church, and scientists. The first class base their estimate of the value of a school upon its success in teaching those subjects that will help the pupil to satisfy his material wants. The question whether the school might not be made to accomplish a nobler end does not seem to concern them. Many of this class would not be disturbed by the introduction of instruction in ethics or even religion into the schools.

From the standpoint of the Catholic Church, the most important thing for a child to learn in this world is how to obtain salvation in the next. Nothing whatever should prevent him from gaining this knowledge. Hence they demand that religion should be taught in the schools, and, because the state schools do not provide for such instruction, the hierarchy has forbidden the children of the Church to attend them, and provides parochial schools instead. They are more strenuous for instruction in religion than in ethics, for the teaching of doctrine than of practical morals. Whether, if it were proposed to introduce instruction in ethics apart from religion, they would favor or oppose such a movement, is a question on which they have not expressed an opinion. To oppose it would seem to be a very inconsistent ground for a Christian body.

The Protestant Church has not yet defined itself so explicitly, but it evidently desires that the schools shall accomplish something better than what they are now doing. The fact that a conference of representatives from the Protestant denominations of New York State was recently held for the purpose of considering religious and moral instruction in the schools is very significant. This conference may be taken as fairly representing the leading sentiment of the Protestant Church in general. Some prominent clergymen present, like their Catholic brethren, would ask the state to give religious instruction; others equally prominent, either because they think that religion is not the province of the school or that it is hopeless to ask for religious instruction, were strongly opposed to this, but would perhaps rather favor carefully restricted instruction in Christian morals.

I have called scientists a fourth class. The term is used in this connection to designate those whose habits of study and thought are scientific rather than religious. They are not necessarily opposed to religion, but seem to have no use for it for themselves. The great advantage to the world which they see in religion is its ethics, but they derive their own code of ethics from another source. Whatever rules of conduct have been proved by experience to be for the good of man in our nineteenth-century civilization constitute the scientist's code of ethics. The question for him, then, in reference to the schools, is not whether any religious creed shall be taught, but, Shall instruction be given in pure, human ethics? Shall the children be instructed in the principles of conduct which have been tested and proved worthy of trust by centuries of experience? This very greatly simplifies the matter, which is hopelessly involved when connected with religion, and at the same time suggests a possible ground for compromise.

A grave difficulty in the way of a compromise is a general lack of definition between religion and ethics. The Church is the one institution which has demanded moral conduct of men. It has taught that eternal damnation is the penalty of wrong-doing and eternal bliss the reward of right-doing, *conjoined* with the acceptance of a certain belief. It has gone so far as to say that there is absolutely no saving virtue in kindness, in justice, in benevolence, in philanthropy of themselves—that there is no salvation in the next world except by means of a so-called "plan" drawn by the Church from Scripture. When an institution of such unmeasured power as the Christian Church has wielded for the past fifteen hundred years utters her dictum on eternal life and death, the world listens, because it believes in immortality. For this reason morality and religion throughout

Christendom have been confused and considered inseparable.

A clear distinction can be drawn, however, between Christian religion and Christian ethics. The Christian religion is the system of beliefs and worship drawn from the life and teachings of Christ. Christian ethics is the system of principles of human conduct drawn from the same source. By far the larger portion of Christ's teachings is devoted to telling men how to live and act, comparatively little devoted to telling them how to worship or what to believe. Whatever else he was, he was certainly a *great teacher of morals.*

The motive which Christ sets before men is, however, religious—viz., the hope of reward in the hereafter. But those principles of conduct which he enunciated, inculcating the spirit of forgiveness, humility, unselfishness, brotherly kindness, purity, charity, and chastity, together with his affirmative golden rule, if practiced, would make a paradise of earth, whether or not any regard was given to a hereafter. What we need in our schools is the direct instruction in such principles and their application to human conduct, and it matters not a whit whether we call them Christian, scientific, or pagan ethics.

If a scientist were to formulate a code of scientific ethics, and a Christian were to formulate a Christian code, the two codes would be strikingly alike. If the Christian were faithful to Scripture, however, he would have at least one point, which is embodied in one of the most fundamental of Christ's precepts concerning duty, that the scientist would not have, viz., "Resist not evil, but whosoever shall smite thee on thy right cheek turn to him the other also." If this had ever been tested in actual practice, it might belong to the scientist's code; but because of its severity as a rule of action theologists have spent much mental energy in explaining it away, and have so far succeeded that in its literal sense it is not generally considered as a part of Christian ethics—at any rate, no Christians practice it, unless perhaps Mr. Tolstoi. With this rule of action eliminated there is no important ethical principle which can form a ground of controversy between scientists and Christians. We assume that on ethical questions there is no material difference between Protestants and Catholics.

Since, then, the ethical codes of earnest scientific thinkers, of the Protestant, and of the Catholic Churches are substantially one, and since there is no hope that the state will ever teach religion in its schools, may we not hope that upon this ground as a basis of compromise something may be accomplished through the schools of vastly greater value to humanity than any degree of manual training or purely intellectual development? The large thoughtlessly indifferent class would certainly not object to such an innovation. Those who are opposed to religious instruction would not be losing their case, because ethics is not religion. All who desire religious instruction to be given would be gaining their object in part, inasmuch as they include ethics in religion. Why not, then, show a spirit of compromise, and, instead of fighting on hopeless lines with divided forces, unite on a platform on which all can stand and fight on lines where there is hope?

The Church is doing a magnificent work toward the correction of the monstrous evils that walk rampant, but it will do vastly more when it comes to place a higher estimate upon human character than it does upon creeds. A portion of the press is doing a grand work, but it will do tenfold more when the entire press comes to care more for cultivating public taste than it does for catering to it. But the schools, which cultivate the fields where richest and most abundant harvests might be reaped, are reaping exceedingly light and scanty harvests, simply because it is not their legal or professed business to do anything toward correcting existing evils or the formation of right character.

B. C. MATHEWS.

86 KEARNEY STREET, NEWARK, N. J.,
February 20, 1891.

EDITOR'S TABLE.

THE YOUNGEST OF THE SCIENCES.

TO know is to be able, to *ken* is to *can:* philology proclaims it, and experience confirms it. Centuries ago the commoner phenomena of electricity and magnetism had attracted attention, but no one suspected that they meant anything in particular, or that they afforded indications of a power everywhere present, and only waiting a summons to enter into the service of man. Yet, let us not too severely blame our ancestors for lack of attention or intelligence. The doors of knowledge have had to be opened one by one, and in early times, when so many doors still remained closed, and others were at best but slightly ajar, it is not to be wondered at that the somewhat recondite and elusive laws of electricity should have re-

mained unexplored. Even in our own century, what a long gap there was between the first production of the electric light and its application to practical purposes! It all seems very plain now, but two generations had to elapse before the electric light, as produced by Sir Humphry Davy in 1808, became available for general use. But if the progress made by electrical science was slow in its earlier stages, amends are truly being made now in the rapidity with which new views and new applications of electricity are crowding upon the world. The alleged miracles of olden time seem poor and commonplace in comparison with the miracles wrought by a little accurate knowledge. Here we have a power that has been in the world from the beginning, but from which, down to the present century, not one single valuable result was drawn, for the simple reason that we, or our predecessors, did not know how to use it, did not even know enough to recognize it in some of its manifestations. To-day, mankind has no more obedient, or, it may be added, capable servant. The early students of electricity had a task that closely resembled putting together a complicated puzzle of which there was no plan; but, as piece was joined to piece, the plan began to reveal itself, and subsequent progress was rapid. To-day, if the puzzle is not complete, at least we have, as far as it goes, a very symmetrical and intelligible pattern before our eyes.

It would be vain to attempt, within the limits of a brief article like the present, to give even a catalogue of the various applications of electricity now in daily use. Like chemistry, electricity has undergone a process of subdivision, and no one man can pretend to keep abreast of the latest developments in all its branches. The year 1837 saw the first telegraph for practical business purposes, and from that time to this there has been a constant stream of improvements in the methods and appliances of the telegraphic art. The whole world is girdled round and round with lines quivering with the impulses that translate the thoughts of men. Enormous as has been the extension of telegraph lines, well-nigh a million miles being now in use in this country alone, they would be utterly inadequate to the needs of the community but for the improvements that have been made in the way of duplex and multiplex telegraphy. The whole business of the world has adapted itself to the changed conditions which the telegraph has introduced. Without the telegraph the railway would be shorn of far more than half its efficiency, and the press of even metropolitan cities would shrink to provincial dimensions. It is becoming difficult to conceive what the state of business would be without even the telephone, which, in every large city, does the work of a whole army of messenger boys. How little we think of electricity when we press the button that closes an electric circuit and rings a bell! Yet the electric bell is certainly one of the most convenient of so-called modern improvements. Without it our great hotels, our public offices, our monster steamships would be much more difficult of management. Our signal service depends upon electricity to outrun the swiftest blasts of storm and herald their approach. The observations of the astronomer would lose much in precision were it not for the simple yet admirable instrument known as the chronograph. For all purposes of instantaneous registration, there is nothing equal to the action of electricity, the velocity of which is equivalent to that of light itself, and its applications for this purpose must go on increasing in number from year to year. Even as it is they are legion.

The electric light would seem to have furnished the world with the final and definitive source of illumination. It is not twenty years since even so good an authority as Prof. Tyndall spoke doubt-

fully of the possibility of distributing the electric light from house to house; but to-day the problem does not present any greater practical difficulty than the distribution of water or gas. When Sir Humphry Davy first made an exhibition of the arc light he used for the purpose a battery of two thousand voltaic cells. Light so produced could never have come into general use on account of the excessive cost. Faraday had to formulate the laws of induction, and the dynamo had to be developed, before Davy's discovery could be turned to practical account, and even then a vast amount of ingenuity had to be expended in the arrangement of details. The incandescent light was a later development. An incandescent lamp is a simple thing to look at, but only those who have studied the subject know how much of laborious experiment and research it took to bring it to its present condition of perfection.

The dynamo which, practically speaking, gives us the electric light, gives us also electric traction and electric power generally. We are only beginning to realize the advantages which our new-found force may have in store for us in this direction. Every month the electric street car is more and more displacing the horse car, with added comfort to passengers and diminished wear of our thoroughfares. Power is conveyed silently over wires from central stations and distributed wherever it may be required for manufacturing purposes, saving a vast outlay in separate boilers and engines, and greatly economizing space. In great telegraph centers the dynamo is displacing cell batteries for the production of current. It is also used for electrolytic operations on a large scale. Nothing, perhaps, is more impressive than to witness the operation at the same moment and on the same spot of three distinct forms of force, mechanical or physical, electrical and chemical, one merging into the other. The water-wheel or the steam-engine furnishes mechanical power; the dynamo, taking up that power, converts it into electrical energy, which again, conducted to an electrolytic cell, is further changed into chemical action. Nothing could more powerfully bring home the lesson that, in the last analysis, all energy is one. Vast industries would disappear from the earth if the various applications of electrolysis could by any means be lost—electro-plating, electrotyping, electro-metallurgy, and a hundred other special applications of electro-chemistry. It takes a considerable effort of thought and memory to realize the extent to the every-day operations of the modern world are dependent upon a power which but a few generations ago was a matter of more or less crude speculation and idle wonder. In electro-welding we have a process, strictly speaking, analogous to the production of the electric light; the energy of electricity is converted into heat at a given point with the most marvelous results. The new science is stretching forth its hands in every direction, and its achievements to-day are but an earnest of what it is destined to accomplish in the near future.

There is, however, another aspect of the matter which is deserving of attention. From having been, up to a short time ago, a subject concerning which the most vague and confused ideas were generally entertained, electricity is now furnishing matter for the formation of one of the most exact sciences. It is true there is a vast amount of popular ignorance respecting it still; one might not, perhaps, have far to go to find "educated" people who imagine that Edison and electricity are almost convertible terms, or at least that electricity was fished bodily out of the depths of the unknown by Edison; nevertheless, the light is spreading, and the very operations which the applications of electricity involve are furnishing a valuable education to a large section of the community. Electricity is above all things measurable, and measurable in a great variety of ways; and the measurement

of electricity implies the investigation from a new standpoint of the various substances used as its conductors. The study of this particular agency, therefore, involves the study of a great number of related things, and thus directly tends to an enlargement of mental grasp. It has, if we mistake not, another most interesting side. All natural sciences, by the analogies they supply, throw more or less light upon the operations of mind and the movements of social forces. Electricity, we believe, will furnish the most instructive ones of all, but we can not to-day more than throw out the hint. Physical science, let us say in conclusion, is bringing noble gifts to the feet of mankind; it is for mankind to see that they use these nobly and wisely.

THE DOCTRINE OF NATURAL SELECTION.

THERE has been a very industrious outcry in certain quarters lately, to the effect that the doctrine of Natural Selection was losing ground; and certain reactionaries have been allowing themselves to entertain great hopes that all might yet be well with their antiquated ideas. As a very apt and powerful answer to this contention came Mr. Wallace's book on Darwinism, in which, in the line of animal creation, he claimed more for the action of natural selection than even Darwin had done. Following close on it came the interesting treatise of Mr. E. B. Poulton, F. R. S., on the Colors of Animals. The last paragraph of Mr. Poulton's preface is worth quoting entire:

"Above all, I should wish to acknowledge, although I can never fully express the depth of my indebtedness to the principles which first made Biology a science, the principles enunciated by Charles Darwin. It is common enough nowadays to hear of new hypotheses, which are believed by their inventors to explain the fact of evolution. These hypotheses are as destructive of one another as they are supposed to be of natural selection, which remains as the one solid foundation on which evolution rests. I have wished to express this conviction, because my name has been used as part of the support for an opposite opinion, by an anonymous writer in the Edinburgh Review. In an article in which unfairness is as conspicuous as the prejudice to which it is due, I am classed as one of those 'industrious young observers' who 'are accumulating facts telling with more or less force against pure Darwinism.' On the strength of this and other almost equally strange evidence, the reviewer triumphantly exclaims, 'Darwin, the thanes fly from thee!' In view of this public mention of my name, I may, perhaps, be excused for making the personal statement that any scientific work which I have had the opportunity of doing has been inspired by one firm purpose—the desire to support, in however small a degree, and to illustrate by new examples, those great principles which we owe to the life and writings of Charles Darwin, and especially the pre-eminent principle of natural selection."

Mr. Poulton may express himself, perhaps, a little over-enthusiastically; but surely there is much significance in the protest which he raises against being quoted on the anti-Darwinian side. One substantial piece of manufactured evidence not only vanishes entirely, but has its place taken by an energetic assertion of the contrary position. Evidences, indeed, that the doctrine of evolution has become almost a fixed principle with scientific workers are to be found on every hand. When men of any scientific eminence whatever, like the late Prof. Sedgwick, in England, or Sir William Dawson, of Canada, refuse it their adhesion, their position becomes one of such singularity as powerfully to prove the rule as to the direction the scientific world at large has taken. One of the most conservative publications of the day in England

is the Quarterly Review, and this is what we find in the very last number of that periodical on the subject of Sedgwick's non-acceptance of the modern standpoint in geology: "In co-ordinating the vast array of (geological) facts so as to form out of them a basis for the great cosmical theories which are the inheritance of his successors, he lagged behind his more philosophical contemporaries. He never broke loose from the entanglement of attempted reconciliations with the biblical cosmogony, never ceased to invoke 'successive creations of the organic kingdoms' to account for the order of life revealed in the rocks and clays. Lyell's great generalization of uniformity was always a stumbling-block to him, and evolution in every shape was to the end hated by him with a perfect hatred. It was years before he could discard the puerile idea that the 'vast masses of diluvial gravel scattered almost over the surface of the earth' were all due to the single catastrophe of the Noachian Deluge; and not till after half a century of geological study could he bring himself to ascribe any validity to the evidences for the vast antiquity of the human race, as contrasted with the historical period." The Quarterly Review, in spite of its general conservatism, is evidently in line with modern thought on these subjects. All the more amazing is it that some men should be found to talk as if the old conceptions were still valid, and the work of the evolutionist school had been in vain.

LITERARY NOTICES.

A Handbook of Descriptive and Practical Astronomy. By George F. Chambers, F. R. A. S. Fourth edition. New York: Macmillan & Co. (Three volumes.) Pp. 676, 558, 364. Price, $14.

For a quarter of a century Chambers's Handbook of Descriptive and Practical Astronomy has been in the hands of all English-speaking astronomers, and has maintained its ground as a valuable book of reference and an interesting summary of astronomical knowledge. In the fourth edition, now issued, the author has divided the work into three separate volumes, treating respectively of The Sun, Planets, and Comets; Instruments and Practical Astronomy; and The Starry Heavens. Each volume has its own independent index and paging. The author's reason for splitting up this well-known book is that so much expansion was required in order to bring it up to date that a single volume of convenient size could no longer contain the matter.

Three or four features of the work may be at once pointed out as especially useful and interesting to amateur astronomers. These are the catalogues of comets and the historical account of eclipses of the sun in the first volume; the elaborate description of telescopes and other instruments used by the astronomer, and the account of chronological astronomy in the second volume; and the photometric catalogue of naked-eye stars in the concluding volume. The compact chronological sketch of astronomy in tabular form, given in the second volume, may also be mentioned as very convenient for reference. This could have been made far more satisfactory, however, if the author had taken the trouble to insert, in all cases, the Christian as well as the surnames of the many astronomers included in his lists.

The whole work is, of course, a compilation, drawn from every available source, and, on account of the somewhat heterogeneous nature of much of the material of which it is composed, lacking in that perfect unity of composition which, when present, gives an irresistible charm to a book. But the author probably had no thought of writing a work that should attain great popularity among mere readers. His intention was to furnish, as his title implies, a handbook or guide-book of astronomy, rich in information and as complete as possible in the matter of reference. The bottoms of his pages are, indeed, filled with a great variety of references to authorities, which can not fail to prove very useful to the student. He has also drawn his illustrations from many sources—German, French, Italian, and American, as well as English—and has only left it to be wished that he had included some of the photographs that have within the past few years thrown such a flood of light upon

celestial phenomena. The old pictures of spiral nebulæ are hardly worth retaining, except for the purpose of comparison, when such photographs as those of Mr. Roberts, the Henry Brothers, and others are obtainable. An interesting feature of the illustrations retained from the preceding editions is the series of pictures of double and multiple stars. These are of material assistance to the amateur in observations of close doubles whose components can barely be separated by the highest powers of the telescope. In this edition the stars in the picture of that wonderful vari-colored cluster which Sir John Herschel discovered near Kappa Crucis, and which he compared to a casket of many-hued gems, have been represented of their proper colors, and the effect is both pleasing and instructive.

The catalogues of binary and multiple stars, and of variable, red, and temporary stars, add much to the usefulness of the volume devoted to the starry heavens.

We are acquainted with no book that contains so much practical information for the amateur about the instruments of the astronomer, their construction, and the methods of mounting and using them, as does the second volume of Mr. Chambers's work. This information ranges from the magnifying powers of different forms of eye-pieces and the proper adjustment of object-glasses to the construction of observatories and the discussion of the best methods of adjusting and mounting telescopes, transit instruments, astronomical clocks, and so on. There is a great variety of practical hints and directions for the guidance of the amateur in the actual work of observation.

In view of the great development of popular interest in astronomy which the past ten years have witnessed, such a work as this must find a rapidly increasing circle of readers; and the author was probably wise in enlarging its scope, in the face of the great increase of cost involved in the change from one volume to three.

NINTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY, 1887–'88. J. W. POWELL, Director. Washington. Pp. 717, quarto.

IN reviewing the work of the many divisions of the Geological Survey during its ninth year, the director states that topographical surveys covering 52,062 square miles have been made by the Division of Geography. The largest areas were surveyed in Missouri, New Mexico, Virginia, Texas, and Arkansas. In Massachusetts, the survey undertaken in co-operation with the State authorities was completed. The examination of the swamp and marsh lands along the Atlantic coast south of New York was continued. These lands, "deleterious to health in their natural condition, an obstacle in the way of approach to the sea, repellent to the settler, to agriculture, and to manufactures, they yet hold out the hope of highly productive utilization through the judicious application of capital." Investigations were carried on also in many other localities, and much laboratory and office work was done. The director gives sketches of the life-work of four prominent members of the survey whose deaths occurred during the year, namely, F. V. Hayden, R. D. Irving, James Stevenson, and Thomas Hampson. Reports from the several chiefs of divisions give the details of the work in their several departments. Of the papers accompanying the director's report, the most extended one is on the Charleston earthquake of August 31, 1886, by Captain Clarence E. Dutton. The chief result obtained from this study is a close approximation to the rate at which an earthquake wave moves, and this is found to coincide with the theoretical rate. Although severe labor was expended for many months in an attempt to obtain some information respecting the cause of earthquakes, the data yielded nothing on this point. The monograph is introduced by accounts of the earthquake by three residents of Charleston who experienced it. One of these, by Mr. Carl McKinley, of the News and Courier, was prepared for the annual report of the city government. Dr. G. E. Manigault, of the Charleston College, was selected to prepare an account especially for this record, and the third was written by Mr. F. R. Fisher. The following chapters embrace detailed studies of the local effects of the earthquake and of the epicentral tracts, a summary view of the effects throughout the country, a computation of the depths of the foci, and discussions of the isoseismals, the speed of propagation through the ground of the principal vibrations, and the

nature of wave-motion through solid bodies. Two epicentrums were found—one near Woodstock, about sixteen miles northwest of Charleston, the other almost due west of the city and about thirteen miles distant. In the investigation of the tracts around these points Captain Dutton gives high praise to the labors of Mr. Earle Sloan, of Charleston. The paper occupies three hundred and twenty-eight pages, and is copiously illustrated with views of ruined buildings, displaced tracks on the railroads, fissures and craterlets in various places, and with maps and diagrams. Prof. N. S. Shaler contributes to this volume a report on The Geology of Cape Ann, Massachusetts, comprising the general structure of the district, its superficial geology, the structure and nature of the bed-rocks, and the relations of the region to the anticlinal axis of which it forms a part. This paper also is fully illustrated. There is an account of the Formation of Travertine and Siliceous Sinter by the Vegetation of Hot Springs, prepared by Walter H. Weed, which is illustrated with many views of the springs in the Yellowstone National Park. The volume includes also a report On the Geology and Physiography of a Portion of Northwestern Colorado and Adjacent Parts of Utah and Wyoming, by Charles A. White, containing maps and diagrams.

ENGLISH PROSE: ITS ELEMENTS, HISTORY, AND USAGE. By JOHN EARLE, Rawlinsonian Professor of Anglo-Saxon in the University of Oxford. New York: G. P. Putnam's Sons. Pp. 530. Price, $3.50.

To give a brief though incomplete characterization of this work, it may be called a book on rhetoric, but it is deeper and broader than such a description would imply. The first chapter deals with choice of expression, giving parallel lists of words of Anglo-Saxon, of French, and of classical origin, and pointing out the principles which should guide a writer in using one or another of these synonyms in a given place. Some of the higher grammatical considerations are next discussed, after which the author passes to the bearings of philology on the writing of English prose. These chapters, with a short one on "mechanical appliances"—i. e., capitals and punctuation marks—make up what the author calls the analytic portion of the treatise. The subject is next treated synthetically in five chapters. The first two of these deal with the leading characteristics of prose diction—elevation, lucidity, variety, novelty, and figure being enumerated under this head. Separate chapters are devoted to idiom and to euphony, and a discussion of style closes this portion of the volume. A brief history of English prose follows. This history is divided into three periods: the first extends from the eighth century to what the author calls the first culmination of English prose in the tenth, and the second ends in the fifteenth century. A closing chapter, entitled The Pen of a Ready Writer, is a good sample of the whole book. Under this head the author affirms that "it is not an easy matter to write English prose that is worth reading." A great number of rules, directions, and cautions are to be considered, he says; but the mind of the writer should not be burdened with a consciousness of these rules at the time of writing. Next after rudimentary grammar and the reading of good authors, philology is the preparation required for writing English. The writer should strive to gain command of the wealth of the English vocabulary. As to classical training, he takes the ground that it is excellent for some purposes, but not for forming an English style. He recommends a study of the English prose of the tenth century, and notes with approval a tendency of current writers to select their leading words from the true mother tongue. The severe drill in choosing words which is enforced by the writing of poetry is a good preparation for writing prose. The volume has an index to quotations, but no general index.

BIOLOGICAL LECTURES DELIVERED AT THE MARINE BIOLOGICAL LABORATORY OF WOOD'S HOLL. Boston: Ginn & Co. Pp. 250.

ALL but two of the ten lectures in this volume were delivered during the summer of 1890. They are published as a contribution to educational literature, and as a means of making known the needs and possibilities of biological work to the patrons of the laboratory and to the general public. One important purpose of this course of lectures was, as stated by Prof. C. O. Whitman in the preface, "to bring specialists

into mutually helpful and stimulating relations with one another." This is necessary, he says, because as specialization advances the mutual dependence of specialists increases, and isolation in work becomes more and more unendurable. The first lecture is by Prof. Whitman, on Specialization and Organization, in the course of which he states that a national marine biological station with a strong endowment is the great desideratum of American biology The second lecture, on The Naturalist's Occupation, is also by Prof. Whitman, and the others are Some Problems of Annelid Morphology, by E. B. Wilson; The Gastræa Theory and its Successors, by J. P. McMurrich; Weismann and Maupas on the Origin of Death, by Edwin G. Gardiner; Evolution and Heredity, by Henry F. Osborn; The Relationships of the Sea-Spiders, by T. H. Morgan; On Caryokinesis, by S. Watase; The Ear of Man: its Past, Present, and Future, by Howard Ayres; The Study of Ocean Temperatures and Currents, by William Libber, Jr. The lectures are rather popular in character, and some of them are illustrated with diagrams.

SECOND ANNUAL REPORT ON THE STATISTICS OF RAILWAYS IN THE UNITED STATES TO THE INTERSTATE COMMERCE COMMISSION, for the Year ending June 30, 1889. By HENRY C. ADAMS. Washington: Government Printing-Office. Pp. 566.

THE railway mileage of the United States at the date of making the report was 157,758·83 miles, of which 149,948·66 miles were covered by reports to the commission. The largest mileage is in Illinois, 9,829·48 miles, and the smallest in the District of Columbia, 30·57 miles, but the District has the most railroad to the square mile and Nevada the least. The gauges of tracks are being rapidly accommodated to two standards. The standard gauge, from four feet eight and a half inches to four feet nine inches, inclusive, is used by 1,371 roads, representing 93·3 per cent of the total mileage, and the three-foot narrow gauge by 234 companies, representing six per cent of the total mileage. This shows ninety-nine per cent of the whole as conformed to these two gauges. Of the 25,665 passenger-cars in use, 23,348 are fitted with automatic couplers and 23,546 with automatic brakes; but the freight-cars are not so well provided, so that out of a total equipment of 1,097,591 engines and cars only 80,510 are fitted with automatic couplers and 128,159 with automatic brakes. As compared with foreign railway administration, the number of men employed per mile of line is remarkably small. The record of accidents to men employed "shows in a startling manner the dangerous nature of railway employment"; and a comparison in the matter with England "is greatly to the discredit of the United States." Information is given respecting the organization of property for operation, on the relations of the roads in a system to one another, the capitalization of railway property, earnings and expenses, and the merits and defects of railway statistics. Complications introduced by construction accounts, express companies, outside freight lines and car companies, and private and corporative ownership of rolling-stock make it difficult to obtain complete statistics; but, as far as the work of the railway companies proper is concerned, a fairly satisfactory exhibit is made. The tables in the appendixes give, of detailed information for the year: Classification of railways and mileage, amount of railway capital, earnings and income, general expenditures, payments on railway capital, and summary of financial operations of operating roads.

GRAMMAR AND LANGUAGE. By E. DE L. STARCK. Boston: W. B. Clarke & Carruth. Pp. 185. Price, $2.50.

THIS book is defined in the sub-title as An Attempt at the Introduction of Logic into Grammar. The attempt is intended to be applied no further than to the seven languages with which the author is acquainted, among which the three groups of the Indo-European family—the Teutonic, the Slavic, and the Romance—are represented. The author believes that he discovers a general principle underlying linguistic phenomena. Grammar has, he affirms, been studied too much from the pedagogical side of the question, while the scientific side has been left out. It has been a drawback in the study of foreign languages that each one is presented to the student disconnected from his mother tongue or any other. On the other hand, the principles of general grammar, in crown-

ing the study of the mother tongue, ought to lay a foundation for foreign languages. It results from the investigation of the principles of classification, that as speaking is nothing but a thinking aloud, it is the man's mind and the outside world as seen by him, but not the use of words, that ought to supply us with the principles. As the same classes of words exist in the different languages, a uniformity may be supposed in the building up of the framework of the sentence. It is sought to establish this as the mere skeleton of the syntactical unit, while each language is left free as to the details of the agreement, government, and order of the words, as far as this is necessary for the manifestation of its individuality and automatism. With this point in view, the theory of the single sentence is sketched in its principal outlines, as it is exhibited by the seven languages. The forms and inflections are then considered. These investigations elicit the fact that language satisfies the requirements of objectivity and subjectivity, both in the formation of its words and in the subsequent changes of their terminations, and thus makes them fit to play their part in the sentence and give needed expression to the variety of thoughts, volitions, and emotions. Yet notwithstanding the objective and subjective world are the same for all, each language has developed different forms for certain classes of words, and other modifications out of which its individuality and idiomatism are developed. Hence there are different structures and orders of words, and these are the subject of the fourth and last chapter of the book.

NEW YORK. By THEODORE ROOSEVELT. Longmans, Green & Co. Pp. 232, with Maps. Price, $1.25.

THIS volume belongs to the "Historic Towns" series. The author confesses to having been tempted to make a more voluminous history than was adapted to the place and purpose of the book, but he has kept within bounds, and has made a presentment which is brief and altogether attractive. It has been his aim, less to collect new facts than to draw from the storehouse of facts already collected "those which were of real importance in New York history, and to show their true meaning and their relations to one another, to sketch the workings of the town's life, social, commercial, and political, with their sharp transformations and contrasts, and to trace the causes which gradually changed a little Dutch trading hamlet into a huge American city. I have also striven to make clear the logical sequence and continuity of these events; to outline the steps by which the city gradually obtained a free political life, and to give proper prominence to the remarkable and ever-recurring revolutions of the make-up of our mixed ethnic population." The author emphasizes the importance of learning to think less of the original nationality of our citizens and more of cultivating a feeling of "broad, radical, and intense Americanism"—looking to the quality of the citizenship rather than to the racial derivation of the citizen. Some of our best citizens are of foreign birth, and some of our worst are of American; and, as was the case with the last four mayors of New York, political lines can not be drawn between them that will not throw a foreigner and an American on one side and a foreigner and an American on the other. It is the man, not the nationality, that we must look to.

HEGEL'S LOGIC. By WILLIAM T. HARRIS, LL. D. Chicago: S. C. Griggs & Co. Pp. 403. Price, $1.50.

THIS volume is the eighth in the series of German philosophical classics published by the house of Griggs & Co., and the third in the series representative of Hegel. The treatise of which it is a critical exposition is defined in the second title as a book on the Genesis of the Categories of the Mind. Prof. Harris's studies of this philosophy began in 1858 with Kant's Critique. But in 1883, when he had promised to prepare this volume, he found himself likely to place before the public an immature work, and to attack what he could not verify with his present insight; so he thought it proper to give himself seven years more of special preparation. His discovery in 1873 of the substantial identity of the East-Indian doctrines—that the differences of systems were superficial, and that the First Principle presupposed and even explicitly stated by the Sanskrit writers was everywhere the same; the principle of Pure Being as the negative

unity of all things—revealed to him Hegel's deep discernment, which, in the dawn of Oriental study, had enabled him to penetrate the true essence of Hindoo thought. Hegel himself has not deduced the logical consequences of his system in the matter of the relation of Nature to the Absolute Idea; and the divergence of his system from the true Absolute Idea is explained by the author in many places. But the wrong explanation of the use of Nature does not vitiate Hegel's theory of human life and of the Christian Church. The inference of a particular species of pantheism from this defect in interpreting the Absolute Idea is regarded as a new criticism of the system of Hegel, of the truth of which Dr. Harris is confident. The interpretation given of the doctrine of reflection, the result of many years of study, is considered the key to Hegel's dialectic, "if anything may be called a 'key' to it"; and the attention of students is called to it in the hope "that a new and fruitful road to Hegel's deeper thoughts may be opened by studying that portion of the Logic which expounds the relation of 'determining reflection' to 'external reflection.'"

A Manual of Weights and Measures, with Rules and Tables. By Oscar Oldberg. Third edition. Chicago: W. T. Keener. Pp. 250.

This book is intended to give complete information on the important subject indicated in its title. It contains the elements of metrology, the relations between metrological systems and arithmetical notation, a brief review of the development of weights and measures, the demands of practical medicine and pharmacy in the matter of subdivision of the units employed; the metric system, American and English weights and measures, the relations of weight to volume, specific weight, specific volume, the construction, use, and preservation of balances or scales, weights and measures, and of alcoholometers, urinometers, and other hydrometers, and extensive tables of equivalents. The laws of the United States, as far as any exist relating to weights and measures, are included. The applications of weights and measures to prescribing and dispensing, and to the construction of formulas for liquid preparations, have received attention. The rules and tables for reduction from one system to another are the most complete that we have seen. The present (the third) edition has been revised, and is believed by the author to be free from errors.

Lake Bonneville. By Grove Karl Gilbert. Monographs of the United States Geological Survey, Vol. I. Washington. Pp. 438, quarto.

One of the most famous geographical features of prehistoric America is Lake Bonneville. The bed of this great body of water, nearly equal to that of Lake Huron in extent, occupied the northwestern part of what is now the Territory of Utah. It has left several sets of clearly marked shore-lines, which have been carefully studied. The Great Salt Lake now occupies about one tenth of the ancient bed, and some smaller existing lakes were included in it. The time of Lake Bonneville was the Quaternary era, or, as the present author prefers to call it, the Pleistocene period. One of the first large works begun by the Geological Survey, under the directorship of Clarence King, was an investigation of the Pleistocene lakes. A volume was to be devoted to the description of Lake Bonneville, and all general discussions were to be deferred until many lakes had been studied. The extension of the field of the survey over the whole United States led to the abandonment of this undertaking, and hence such generalizations as were permitted by the material gathered have been included in the present volume. After an introductory chapter the author takes up the general topographic features of lake shores, pointing out those formed by waves, shore currents, and inflowing streams, and describing the character of an adolescent and of a mature coast. He then applies these principles to the shores of Lake Bonneville. The Bonneville shore-line proper is about 1,000 feet above Great Salt Lake; 375 feet lower is a strongly marked shore-line, called the Provo, made after the lake had shrunken considerably from its greatest extent, and between these two elevations are intermediate shore-lines due to fluctuations of the water surface before the greatest extent was reached. An account is then given of the outlet formed at the north end of Lake Bonneville, where 375 feet of alluvium was quickly cut through,

lowering the water to the Provo level. A chapter is devoted to the lake sediments found within the Bonneville shore-line, after which a connected history of the Bonneville basin is given, and a parallel is drawn between this and the history of Lake Lahontan. The relation of volcanic eruption to the lake history is treated separately, as is also the effect of movements of the earth's crust in deforming the shore-lines. The volume ends with a discussion of the Equus fauna, which is not found within the limits of Lake Bonneville, but which is connected with the lacustrine history introduced into an earlier chapter. There is an appendix on Altitudes and their Determination, by Albert L. Webster, and two on geodetic problems connected with the ancient lake, by R. S. Woodward. The volume is liberally illustrated with full-page, double-page, and many smaller views, maps, diagrams, etc., many of the maps being colored, and there is a folded map of the lake, about three feet by two, which is also printed in colors.

A HISTORICAL GEOGRAPHY OF THE BRITISH COLONIES. By C. P. LUCAS. Vol. II. Oxford, England: Clarendon Press; New York: Macmillan & Co. Pp. 343. Price, $1.90.

PREDOMINANT importance is given in this book to the American colonies, in which British colonization began, and which are the most extensive; and they are historically, statistically, and comparatively presented in tables and diagrams. A distinction is drawn between the North American and the West Indian colonies, while the Bermudas and the Falkland Islands lie outside of both. The North American colonies, though they include islands, are continental; while the West Indian, though they extend to the continent, are, on the whole, a collection of island dependencies. In Canada and Newfoundland the drawbacks to colonization have been ice and snow; in the West Indies they have been tropical heat and hurricanes. In the Northern colonies nearly all the inhabitants are of European origin; in the West Indies blacks predominate. There are other historical as well as racial distinctions, but one point the two groups have in common: "They are settlements, and not mere dependencies. The heat of the West Indies has not prevented the British race from colonizing the islands, and, though the negro race has long been greatly superior in numbers to the white, the history of an island like Barbados shows that even in the tropics the connection between Great Britain and America has been that of permanent settlement rather than of passing trade or foreign rule." The Bermudas, the West Indian colonies, those of the South American coast, the Falkland Islands, and South Georgia are described, historically and geographically, and the descriptions are illustrated by good though small maps.

The relative merits of the incandescent electrical light and some other lights that are suggested are discussed by Prof. *E. L. Nichols*, of Cornell University, on *The Artificial Light of the Future*. The author finds that there are limitations to the life and usefulness of the incandescent light and of the arc light that are not likely to be overcome. Inquiring for a better light, he finds that of magnesium superior in quality and efficiency to any other as yet known. It affords, weight for weight, thirty times the light obtained from gas, with the development of much less heat, and gives the nearest approach to sunlight in whiteness; while in illuminating power each unit of it must be regarded as the equivalent of rather more than 1·25 units of gaslight. It has a quality believed to be the same as that named by Prof. Wiedemann *luminescence*, an effect, akin to phosphorescence, fluorescence, etc., of a different class of molecular vibrations from those which cause incandescence, to which importance is attached, enabling it to radiate light without heat. A similar quality belongs to the oxide of zinc, the properties of which as an illuminating substance are also studied.

From *Wm. Paul Gerhard*, consulting engineer for sanitary works, three monograph pamphlets are received, the nature and value of which are indicated by their titles. They are *Architecture and Sanitation*, in which the advantages of employing a sanitary engineer for building-work related to his sphere are insisted upon; *Notes on Gas-lighting and Gas-fitting*, which abounds in practical suggestions; and the *Disposal of Sewage of Isolated Country Houses*, a matter

that is too often neglected or ignorantly attended to.

A paper on *Faith-Healing in the Sixteenth and Seventeenth Centuries*, read before the American Folk-lore Society by *Charles F. Cox*, is intended to draw a parallel between the superstitious modes of cure and practices of the period named and the faith-cures, etc., of the present, and to show that the latter are what are called, in the theory of evolution, survivals. Illustrations are drawn from the career of Paracelsus, the weapon-salve of Robert Fludd, and the sympathetic powder of Sir Kenelm Digby. The influence of suggestion is supposed to have played a considerable part in such success as the charlatans practicing these cures may have had. The author avows the belief that cures have been, and are nowadays, effected by the methods employed by the different species of faith-healers, and explains them on the theories expounded by Dr. W. B. Carpenter, or as cases of hypnotism.

The *Rules and the Application of Reichert's Hæmometer*, an instrument designed to ascertain the amount of hæmoglobin in either a diseased or a normal condition of the blood, are described by *Frederick Gaertner*, M. D., in a paper which was read before the iron City Microscopical Society, Pittsburg.

Vol. XXIII of Annals of the Astronomical Observatory of Harvard College, of which Part I is published, is devoted to the *Discussion of Observations made with the Meridian Photometer during the Years 1882–1888*, by *Edward C. Pickering* and *Oliver C. Wendell*. The first parts of the investigation of which the continuation is recorded have appeared in a previous volume, and a third volume will be required to contain the whole. A larger instrument than those with which the earlier observations were made, but like it, was applied in the present series to fainter stars. The observations relate principally to stars north of declination −40°. The work having been done at Cambridge, the instrument has been sent to Peru, for observation of the Southern stars. The details of this series will be published in another volume. A careful description is given of the instrument and the method of using it.

In *Consumption and Liquids* a theory of the prophylaxis and cure of consumption by suralimentation of liquid food is presented by *W. H. Burt*, M. D., of Chicago. The author believes that his remedy is not only the greatest of known prophylactics, but that it will arrest and cure pulmonary consumption; that, when used in the first and second stages of phthisis, it will enable the physician to cure more than fifty per cent of the patients that would have to die with the best methods known to medical science up to the present date; but, in the third or last stage, it will give only temporary relief. It should, however, always be combined with the best remedies known to medical science; and, with this in view, the author has added most of the practical remedies in medical literature, together with all the auxiliaries at the command of the physician. Hence his book contains chapters on the etiology and prophylaxis of the disease, the part that water occupies in the human body and its therapeutic value, fruit, and specific remedies. W. T. Keener, publisher, Chicago.

The Geological Survey of Missouri, Arthur Winslow, State Geologist, publishes in Bulletin No. 2 *A Bibliography of the Geology of Missouri*, compiled by F. A. Samson. The author has adopted a system of classification of books and papers into those which are products of individual investigation—with entire or with partial reference to Missouri; compilations from publications of original investigation; and incidental or dependent publications. To the first class belong reports of geological surveys, of the State Board of Internal Improvements, the Bureau of Statistics, the Smithsonian Institution, university and agricultural reports, etc., 472 titles; to the second class, compilations from those made for different offices and institutions and for various purposes, 162 titles; and to the third class, occurring in many ways and places, 167 titles. Of the publications of the State of Missouri there are 144 titles; of the United States Government, 65 titles; of other State surveys, 13 titles; and of miscellaneous publications, 579 titles. The dates of publication of these papers, by decades, show a regularly increasing interest in the subject. Bulletin No. 3 of the same office contains papers on the *Clay, Stone, Lime, and Sand Industries of St. Louis City and County*, by *G. E. Ladd*; and *The Mis-*

eral Waters of Henry, St. Clair, Johnson, and Benton Counties, by *A. E. Woodward*.

The sixteen-page monthly journal, formerly called *The Naturalist*, now comes as *The Kansas City Scientist*, and as the organ of the Kansas City Academy of Sciences, with *R. B. Trouslot* as chief editor. It is filled with original papers, which in the present number (January, 1891) relate to owls—those of Chester County, Pa., and those of eastern Iowa—geological observations in Colorado; the movements of animals; and other matters of personal observation. Price, $1 a year.

The first of a series of three volumes under the general title Epochs of American History, has been published (Longmans, $1.25). This volume deals with *The Colonies: 1492 to 1750*, and the author is *Reuben G. Thwaites*, Secretary of the State Historical Society of Wisconsin. The editor of the series, Dr. A. B. Hart, of Harvard College, states that the purpose of these books is to "show the main causes for the foundation of the colonies, for the formation of the Union, and for the triumph of that Union over disintegrating tendencies. To make clear the development of ideas and institutions from epoch to epoch." Hence no attempt is made to include all the facts that would belong in a complete record. To aid readers who may wish to go into the details of narrative and social history, each chapter throughout the series is to be provided with a bibliography. Historical geography will receive especial attention. The present volume contains four maps, one showing the physical features of the United States, the other three showing how the country was divided among England, France, Spain, etc., at different periods. The author of the first volume, in mentioning some of the topics he has treated, says: "The social and economic condition of the people is described, and attention is paid to the political characteristics of the several colonies, both in the conduct of their local affairs and in their relations with each other and the mother-country. . . . Attention is called to the fact, generally overlooked, that the thirteen mainland colonies which revolted in 1776 were not all of the English colonial establishments in America; a chapter is devoted to a description of the several outlying sister colonies, showing wherein they differed from the thirteen, and why they did not join in the revolt." The matter of the volume is conveniently arranged, and is fully indexed.

Recognizing the interest which students of American history and politics must take in the study of federal government as being in effect a study of the principles underlying their own institutions, Prof. *Albert Bushnell Hart* has prepared for the series of Harvard Historical Monographs (Ginn & Co.) an *Introduction to the Study of Federal Government*. The development of the federal system is noticed as having been one of the most striking political tendencies of the last century, and has been exemplified on a considerable scale in Switzerland, Germany, England and its colonies and dependencies, Canada, the South American states, and, pre-eminently, the United States. The present monograph gives, in its first part, an outline of the political history of the several confederations, beginning with the ancient Grecian and Italian leagues and closing with those of Latin America; and in the second part a parallel view of the four leading federal constitutions now in operation, in which each constitution is made to serve as a practical commentary on the others. In a chapter on The Theory of Federal Government, the doctrine of sovereignty is defined, certain new federal combinations of states are described, the nature of federal government is analyzed, federal governments are classified, and their political conditions are considered.

The French Invasion of Ireland in '98, an episode of the French Revolution that has heretofore received little attention, has been made the subject of a volume by *Valerian Gribayédoff* (C. P. Somerby, New York, $1.50). The story is told in a popular way, and is attractively illustrated. The pictures include battle-scenes and portraits, most of the latter being drawn by the author. The record is substantiated by frequent reference to contemporary accounts, and the appendix contains several letters bearing on the events of the campaign.

Political Americanisms (Longmans) is a convenient and useful glossary of terms and phrases current at different periods in American politics, by *Charles Ledyard Nor-*

ton. "It is impossible," the compiler remarks, "to look over the columns of a daily journal, especially during the progress of a spirited political campaign, without encountering numerous expressions and phrases, the meaning of which can not be learned from any dictionary, but which, to one who is familiar with the current *argot* of the period, are often quite as vigorously expressive as the most picturesque slang of the street." Mr. Norton's attempt is to explain most of these expressions. Without claiming to be exhaustive, he has included a number of phrases which, he says, can be found in no other compilation. Some have passed out of current use, others are still living. The definitions are studiously uncolored.

Prof. *J. Howard Gore*, in a paper on *The Decimal System of Measures of the Seventeenth Century*, presents the claims of the priest, Gabriel Mouton, of Lyons, to be regarded as the originator of the decimal system. As early as 1665 he proposed a scheme of measures by tens, the unit of which was derived from a minute of the arc of the terrestrial great circle, and which embodied the essential features of the scale proposed by the official commission in 1799.

W. M. Griswold, the industrious index-maker, has prepared and publishes, at Cambridge, Mass., in a pamphlet of fifty-two pages, *A Descriptive List of Novels and Tales dealing with American Country Life*. Its purpose is to direct readers, having a taste for books of the kind, to a number of novels, easily obtainable, but which may have become forgotten in the rush of other novels coming after them. Many of these books are typical, or have a historical value; some of them are of the first quality of excellence, and should not be allowed to perish at least in the present age; and all are worthy of the place given them. Descriptive notices are appended to each of the titles, which have usually been selected from reviews in the standard critical journals. Other lists of kindred character are promised.

The Indiana *College Association* was formed in 1878 for the mutual improvement of its members and the consideration of college instruction and management, and now includes representatives of fourteen institutions. It has held meetings every year, but no publications were made of the proceedings of its meetings from 1884 to 1888. The full publication of the *Proceedings and Addresses* of the thirteenth session, December, 1890, is accompanied by abstracts of the proceedings of these five sessions. The principal addresses at the meeting of 1889 were on The Religious Sentiment in its Relation to Scholarship, President J. J. Mills; Relations of Mathematics to Metaphysics, Prof. A. S. Hunter; The Function of the Laboratory in Technical Schools, Prof. Thomas Gray; The Study of Man through Language and Literature, Prof. Hoffman; Word Color, Prof. E. B. T. Spencer; and Mathematics in the Preparatory Schools, Prof. R. J. Aley.

A strange volume is that entitled *A Secret Institution*, written by *Clarissa C. Lathrop* (Bryant Publishing Co.), to describe the events that led to her incarceration in the Utica Insane Asylum from 1880 to 1882, her treatment there, and the way she obtained her release. Its purpose is to call attention to the injustice which many persons have suffered through being committed to asylums and kept there when perfectly sane. The writer draws a dark picture of asylum life, and her story shows what terrible abuses are possible where the light of investigation can not penetrate.

A novel in which a representation of one of the current forms of socialism is given has been written by *Albion W. Tourgee*, under the title *Murvale Eastman, Christian Socialist* (Fords, $1.50). The social doctrines are applied in the dealings of a street railway company with its employés. The story is more than a mere vehicle for the doctrines, being rich in plot and incident.

A number of geological monographs of much interest have recently been published by Prof. *Warren Upham*. First on the list in the amount of labor it represents is the author's *Report of Exploration of the Glacial Lake Agassiz in Manitoba*, which appears in connection with the report of the geological survey of Canada. Lake Agassiz was a lake, the result of the damming of the waters by ice in glacial times, which existed in the Red River Valley in Dakota and Minnesota, and thence toward the north across Manitoba into Saskatchewan, covering an area (about 110,000 square miles) greater

than that of the five Laurentian lakes combined. Prof. Upham having studied the remains of this lake as defined by its ancient beaches in the United States, obtained authority from the Canadian survey to carry on his investigations in the British territory, and his paper of one hundred and fifty-six pages furnishes the evidence that he did so very carefully. The paper is illustrated by a map of the country of Lake Agassiz, showing its position and probable extent and its relation to the Upper Laurentian lakes, and by a map of its beaches and deltas in southern Manitoba. Many artesian wells have been obtained in the plain which occupies the site of the valley of the ancient lake, and the description of these furnishes the substance of a paper on *Artesian Wells in North and South Dakota*. Prof. Upham is not confident that the wells can be made efficient in these regions for irrigation. A well flowing one hundred gallons a minute would be needed to irrigate a quarter section, or one hundred and sixty acres of land—the usual area of a homestead. Such a well would cost seven thousand dollars, and to this the outlay for reservoirs and conduits would have to be added. *A Discussion of the Climatic Conditions of the Glacial Period* was participated in, in the Boston Society of Natural History, by Frank Leverett, Prof. Shaler, and Prof. W. O. Crosby, with Prof. Upham. Prof. Upham thought the conditions most favorable to the formation of the ice-sheets were long-continued rather than excessive cold, with an abundant supply of moisture by storms, and cooler summers than now. In a fifth paper the *Fiords and Great Lake Basins of North America* are considered as evidence of pre-glacial continental elevation and of depression during the Glacial period.

PUBLICATIONS RECEIVED.

Agricultural Colleges and Experiment Stations, Reports and Bulletins.—Cornell University. Third Annual Report. Pp. 54.—University of Illinois. Bulletins Nos. 13, 14, and 15 (Corn, Milk, and the Fruit-bark Beetle). Pp. 64, 16, and 28.—Kansas Agricultural College. Second Annual Report. Pp. 153.—Massachusetts Agricultural College. Twenty-eighth Annual Report. Pp. 69.—Michican (Vegetables). Pp. 41.—New Jersey (Fertilizers). Pp. 24.—Utah Agricultural College. First Annual Report. Pp. 32.

Agriculture, Department of, Washington. The Work of the Agricultural Experiment Stations. Pp. 16.

Amateur Electrician. Monthly. Ravenswood, Ill. Pp. 26. $1 a year.

Bandelier, A. F. Contributions to the History of the Southwestern Portion of the United States. Cambridge, Mass.: Archæological Institute of America. Pp. 206, with Map.

Barrows, Henry D. International Bimetallism. Los Angeles, Cal.: Stoll & Thayer. Pp. 55.

Billings, John S., M. D. Public Health and Municipal Government. Philadelphia: American Academy of Political and Social Science. Pp. 23.

Brown, George P. Religious Instruction in State Schools. Bloomington, Ill. Pp 8.

Brown, Thomas J. Civilian Directorship of the New Weather Bureau.

California State Mining Bureau. Preliminary Mineralogical and Geological Map of the State of California. 4 sheets.

Carus, Paul. The Soul of Man. Chicago: Open Court Publishing Co. Pp. 458. $3.

Coast and Geodetic Survey, United States. Report on Oyster Culture in Georgia. By Ensign J. C. Drake. Pp. 30, with Maps.—Determination of an Azimuth. By A. T. Musman. Pp. 4.—Bering's Magnetic Observations. By C. A. Schott. Pp. 4

Comstock, Theodore B. Geology of the Central Mineral Region of Texas. Austin. Pp. 154.

Cotterill, J. H., and Slade, J. H. Lessons in Applied Mechanics. Macmillan & Co. Pp. 517. $1.25.

Crothers, T. D. Relation of Life Insurance to Inebriety. Pp. 2.

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Crooker, J. H. Different Views of Jesus. Boston: American Unitarian Association. Pp. 30.

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Eggleston, G. C., and Marbourg, Dolores. Juggernaut. Fords, Howard & Hulbert. Pp. 348. $1.25.

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Gilman, Nicholas Paine. Industrial Partnership or Profit-sharing. Pp. 18.

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Iowa State Medical Society. Transactions, 1890. Cedar Rapids. Pp. 307.

Keen, William W., M. D., Philadelphia. Nephrorrhaphy. Pp. 35.—Spasmodic Wryneck. Pp. 4.

Larison, C. W., M. D., Ringos, N. J. The Journal of Health. Monthly. Pp. 16. $1 a year.

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Page, Dr. Charles E. Typhoid Fever. Boston: A. Mudge & Son. Pp. 28.

Palm, Andrew J. The Death Penalty. G. P. Putnam's Sons. Pp. 241. $1.25.

Parker, William W., M. D., Richmond, Va. The Rise and Decline of Homœopathy. Pp. 12.—Burial *vs.* Cremation. Pp. 8.

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Rosse, Irving C., Washington. Clinical Evidences of Border-land Insanity. Pp. 16.

Salmon, David. Longmans' Primary School Grammar. Longmans. Pp. 124. 35 cents.

Sanborn, J. W. Missouri Experiment Station. Synopsis of Experiments. Pp. 40.

Shoup, Francis A. Mechanism and Personality. Ginn & Co. Pp. 348. $1.80.

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Waith, William S. The Circle of Trigonometric Functions. Pp. 32.

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Woolsey, W. J., St. Paul, Minn. Prophetic Evolution. Pp. 16.

POPULAR MISCELLANY.

Our Sequoia Forests.—Counting as forests all areas of a thousand acres and upward, Mr. Frank J. Walker computes that there are now 37,200 acres of Sequoia forest in the United States, divided as follows: King's River forest, 7,500 acres; Kaweah River, 14,000; Tule River, 14,000; Kern River, 1,700 acres. They are all south of King's River, and nearly all of them in Tulare County, Cal., and extend over a belt of country beginning at Converse Basin on the north, and ending with the Indian Reservation forest. The groves and forests within this region are more than twenty in number, with an average distance between them of perhaps three or four miles. The southern limit of the Sequoia is the Deer Creek Grove, which contains less than one hundred and fifty Sequoias, scattered over an area of perhaps three hundred acres. Too many of these noble woods have already passed into the hands of speculators, and are doomed shortly to disappear. One tract, including two townships, has lately been saved to the public by the Vandever Bill. It embraces the Sequoia Park forest and most of the Homer Peak forest, and contains what are known as the Fresno Big Trees—among them the General Grant, which is said to be forty feet in diameter. Besides its value for the storage of waters needed for irrigation, this whole region has charming natural attractions that make it most eminently suitable for a park, of which Mr. Walker says: "The height of the Sierra, culminating in Mount Whitney, affords grand scenery of peculiar charm and great variety. Here are three Yosemites rivaling their noted prototype in many features, with a little world of wonders clustering around the head-waters of Kern, Kaweah, and King's Rivers. We will simply mention the Grand Cañon of the Kern, where, for twenty miles, the mad waters of the river are walled in with the continuous battlements of the California Alps, crowned with nameless and unnumbered domes and towers. Then, only a few miles across the divide, extends the cañon of King's River, with its wealth of impressive scenery; and some eight miles farther to the north lies the Valley of Tehipitec—the gem of the Sierra—with its wondrous dome of rock rising in rounded majesty some six thousand feet from the level of the river-cleft meadow at its feet. A view of the most impressive and characteristic scenery of the region is to be earned by scaling one of the lofty peaks of the Kaweah range. At least a hundred peaks here rise to altitudes exceeding ten thousand feet. . . . Here, standing on the crest of the Kaweah Sierra, one looks across the Grand Cañon of the Kern, and the encircling wilderness of crags and peaks is beyond the power of pen to describe. Mounts Moriache, Whitney, Williamson, Tyndall, Kaweah, and a hundred nameless peaks—the crown of our country—have pierced the mantle of green that clothes the cañons below, and are piled into the very sky, jagged and bald, and bleak and hoary—a wilderness of eternal desolation."

The Custom of Potlatch.—One of the most complicated and interesting institutions of the Northwestern Indian tribes of Canada, according to Mr. Horatio Hale's report on the subject to the British Association, is what is called *potlatch*—the custom of paying debts and of acquiring distinction by means of giving a great feast and making presents to all the guests. It is somewhat difficult to understand the meaning of the *potlatch*. The author would compare its most simple

form to our custom of invitation or making presents, and the obligations arising from the offering, not from the acceptance, of such invitations and presents. Indeed, the system is almost exactly analogous, with the sole exception that the Indian is more anxious to outdo the first giver than the civilized European, who, however, has the same tendency, and that what is custom with us is law to the Indian. Thus by continued *potlatches* each man becomes necessarily the debtor of the other. According to Indian ideas, any moral or material harm done to a man can be made good by an adequate *potlatch*. Thus, if a man is ridiculed by another, he gives away a number of blankets to his friends, and so regains his former standing. I remember, for instance, that the grandson of a chief in Hope Island, by unskillful management of his little canoe, was upset near the beach and had to wade ashore. The grandfather felt ashamed on account of the boy's accident, and gave away blankets to take away the occasion of remarks on this subject. In the same way a man who feels injured by another will destroy a certain amount of property; then his adversary is compelled to do the same, else a stain of dishonor would rest upon him. This custom may be compared to a case where a member of civilized society gives away for no good purpose a considerable amount of money ostentatiously in order to show his superiority over a detested neighbor. A remarkable feature of the *potlatch* is the custom of giving feasts going beyond the host's means. The procedure on such occasions is also exactly regulated. The foundation of this custom is the solidarity of the individual and the *gens*, or even the tribe, to which he belongs. If an individual gains social distinction, his *gens* participates in it. If he loses in respect, the stain rests also on the *gens*. Therefore the *gens* contributes to the payments to be made at a festival. If the feast is given to foreign tribes, the whole tribe contributes to these payments. The man who intends to give the *potlatch* first borrows as many blankets as he needs from both his friends and from those whom he is going to invite to the feast. Every one lends him as many as he can afford, or according to his rank. At the feast these are given away, each man receiving the more the higher his rank is. All those who have received anything at the *potlatch* have to repay the double amount at a later day, and this is used to repay those who lent blankets. At each such feast the man who gives it acquires a new and more honorable name. In one tribe the chief's son, some time after his father's death, adopts the latter's name. For this purpose he invites all the neighboring tribes to a *potlatch*. During the festival he stands on the permanent scaffold in front of his house, assisted by two slaves, who distribute the presents among the guests sitting or standing in the street. As it is necessary to give a great festival at the assumption of the chief's name, the new chief continues sometimes for years and years to accumulate wealth for the purpose of celebrating this event.

Persistence of Life.—The distinctions between plant and animal, pointed out by Prof. Dana, in the introduction to his Manual of Geology, have reference to the absorption by the plant of carbonic acid and by the animal of oxygen; of manufacturing organic food for the animal by the plant from inorganic materials, etc.—matters which Prof. Persifor Frazer does not regard as concerning the question of the essential continuity of inorganic with organic force, and the separation of the phenomena of the latter from those of the former by an indefinable line. No hard-and-fast line, in Prof. Frazer's view, can be drawn to separate animal from plant, and none to separate plant from crystal. The force which is the cause of production and of change seems as if it were simply modified to suit the various structures which it builds. The material in all three kingdoms of nature is the same. Having reviewed the modes of growth in the three kingdoms, the author concludes that there are strong analogies between them, the divergence being progressive as we go from mineral to plant and from plant to animal. Common characteristics of the three kingdoms are the presence of force, its action upon matter, and its renewal by the change of one form of matter to another, in the course of which energy is manifested. In the crystal kingdom the restrictions on the existence and growth of the individual being least, and the variations of conditions and environment in which ex-

istence is possible greatest, the individuals are more numerous and their composition more diverse. The cycles of changes in the plant and animal kingdom are based for the most part upon the disunion and separate combinations of carbon and hydrogen, because under existing conditions of temperature, etc., these changes can be produced to the greatest advantage of existing kinds of living things and life forces. With a much hotter or colder earth, when the weights of bodies were much greater or less than they are now, not surrounded by an ocean of oxygen gas, or deprived of the chemical force of our sun, some changes would be made in the modes in which life is perpetuated to suit the changed conditions of the planet; "but it is extremely unlikely that life would be extinguished by them unless the conditions changed too suddenly." These changes might affect the kind of matter flowing through the living body, or the attributes of the living thing; or, "if both the elements themselves and the rapidity with which they resolved themselves into new combinations were changed, the diversity of the living things and of the world itself would be so different from what they are now that we have no means of forming the least conception of them. But in none of these cases is it likely that life would become extinct, though the present relations to each other of the three kingdoms of nature would cease to be."

Adulterants as Diluents.—People, as a rule, suppose that any substance used as an adulterant of a food-product, or as a substitute for it, is to be avoided as injurious to health. This, according to Mr. Edgar Richards, is not quite correct. It is, in fact, contrary to a manufacturer's interest to use any substance that would cause injurious symptoms, for it would be detrimental to his business. The majority of substances used for food adulterants or substitutes are cheap and harmless, and do mischief only as they go to dilute the genuine article. The principal adulterant of milk is water; and the great harm of it appears when it is fed to a child or an invalid, who might be starved to death if compelled to rely on watered milk for his sole sustenance. The skill of the milk adulterator has kept pace with the march of improvement; and a centrifugal machine is in the market for manufacturing an artificial cream or milk from skimmed milk and also oil, the strength of which depends on the amount of animal fat added. This, it is said, can be used for all purposes for which genuine milk is employed. Oleomargarine and refined or compound lard are made from what were formerly considered waste products of slaughter-houses. When properly made, with due attention to cleanliness, they furnish a palatable and wholesome product, "which is, however, not intended to compete with 'gilt-edge' butter." Mr. Richards, in fact, prefers compound lard to "prime steam lard," which he characterizes as "about as disgusting a mixture as can be imagined." Cotton-seed oil is used in the manufacture of compound lard, and in the place of olive oil for the table, and in medicinal preparations. The wholesome qualities and purity and uniformity of composition of glucose, or sugar manufactured from starch, have been reported on favorably by a committee of the National Academy of Sciences. However much the public may be cheated in the purchase of ground spices, coffee, etc., adulterated with flours and starches, people are not poisoned by their consumption; and "it is a question how much a purchaser is himself to blame in his endeavor to secure a 'bargain' when he demands a quantity of any given material at less than it can be purchased at wholesale in the market." The addition of antiseptics to food in order to preserve it in transportation is often deleterious and can not be considered safe.

Extraordinary Memories.—Among the recorded instances of marvelous memory is one given by Archdeacon Fearon of a person in his father's parish who could remember clearly all the burials, with the exact dates and all the details, which had taken place there for thirty-five years, but in all other respects was a complete fool. George Watson, according to Hone's Every-day Book, could remember, with like exactness, every event of every day from an early period of his life. Another similar case is that of Daniel McCartney, related in the Journal of Speculative Philosophy. Memory Corner Thompson was able to draw, upon order, exact and perfect plans of many of the

parishes of London, with everything in its place and nothing left out. On the side of the learned, Scaliger read nothing which he could not remember, and committed Homer to memory in twenty-one days, and all the Greek poets in three months. Like powers, changing only the authors learned, were displayed by Bishop Saunderson, Euler, Leibnitz, Gilbert Wakefield, and Porson. The same power is called into action in the acquisition of languages; and here we have the instances of Crassus, who could try cases and pronounce judgments in any of the dialects of his Asiatic prætorate; Mithridates, who administered the laws in all the languages of the twenty-two nations of his empire; Sir William Jones, who knew thirteen languages well, and could read with comparative ease in thirty others; John Leyden, who had a good acquaintance with fifteen languages; George Borrow, who translated prose and poetry from thirty languages; Edward Henry Palmer, who could speak the native tongue of every European nation, and was so perfect a master of Arabic, Persian, Hindustani, Turkish, and the language of the gypsies, that even natives were sometimes deceived as to his nationality; Viscount Strangford and Elihu Burritt, "the learned blacksmith"; Cardinal Mezzofanti, who professed to be able to speak in "only fifty-two" languages; Sir John Bowring, who was much like him in gifts; and Von der Gabelentz, who "seems to have been equally at home with the Suahelis, the Samoyeds, the Hazaras, the Aimaks, the Dyaks, the Dakotas, and the Kiriris; who could translate from Chinese into Manchu, compile a grammar or correct the speech of the inhabitants of the Fiji Islands, New Hebrides, Loyalty Islands, or New Caledonia."

Mobility of Labor.—Discussing in the British Association the effects on mobility of labor of the introduction of machinery and the tendency to production on a large scale, Mr. H. Llewellen Smith defined mobility as the free economic device of employment, by change either of occupation or of place. It is not the same as movement, nor is the one measured by the other. It is measured by the extent to which a set of workers engaged in a particular process, or in making a particular article, would or would not suffer economically by a change in the demand for that process or that article. There is, besides, "initial mobility," or the free effective choice of occupation at the outset. This is effected by the localization of industries and the tendency to heredity, which again is strongest in domestic trades and weakest in factories. The general result reached by discussion is, that modern changes tend to divide up a process of manufacture into a number of detail processes of which one man performs only one, but the various members of the group of workers producing a particular article become less and less specialized with regard to that article, and their range of mobility, which is narrowed as regards power of interchange among themselves, is widened as regards power of interchange with workers engaged in corresponding processes of other trades. Machinery often tends to facilitate this interchange by transferring different manufactures into different groupings of nearly identical detail process. Hence, while dividing up employments on the one hand, machinery reintegrates them on fresh lines. Thus the boundaries of trades and industries are shifting and industries are regrouping themselves. Apprenticeship and trade customs are affected. There is a simultaneous tendency to shorten the time necessary to learn a particular process, and so to increase the ease (though not always the practical opportunity) of interchange among different processes of the same trade.

Rubies and Sapphires in Siam.—The gem-mines of Siam are at Krung, Krat, and Phailin, points or districts dependent on the seaport of Chantabun. They are shortly to be leased; but at present the only condition required for entering the mines is the payment of a small fee to the head man of the district. The digger's first object is to discover a layer of soft, yellowish sand, in which both rubies and sapphires are deposited. This stratum lies at depths varying from a few inches to twenty feet, on a bed of subsoil in which no precious stones are found. A pit is dug, and the soil removed is taken to a neighboring canal or stream, where it is mixed with water and passed through an ordinary hand-sieve. In his

search for this peculiar alluvial deposit, which is generally free from any admixture of clayey earth, the digger has often to penetrate into the jungle that grows thickly around, and combines the work of clearing with the occupation of gem-digger. No sapphire has yet been extracted of higher value than about fourteen hundred dollars, or ruby of higher price than forty-eight hundred dollars. No artificial or mechanical processes for washing the soil have so far been introduced. Rubies and sapphires are found at all the diggings, often deposited side by side, in the same layer or stratum of sand. The rubies are usually of a dull, light-red hue. The sapphire is of a dark, dull blue, without any of the silken gloss distinctive of the Burmah and Ceylon stones. Stones resembling garnets rather than rubies are found in the dried beds of water-courses at Raheng, two hundred miles north of Bangkok, and there is every reason to believe that rubies, also, at least equal to those discovered in the southeast, exist throughout the Raheng district.

What may be learned from a Spinning Top.—The earth as a spinning top was substantially the subject of an "Operatives' Lecture," by Prof. John Perry, at the British Association. The lecturer's purpose was to exhibit the analogies between the motions of tops and the rotation of the earth, and show how many phenomena can be explained by them. He said that, if more attention was paid to the spinning of tops, much greater advances would be made in mechanical engineering and industrial invention; geologists would not make so many mistakes of millions of years in their calculations; and we should all have a much better knowledge of astronomy, of light, of magnetism, and of electro-magnetic subjects. First the lecturer illustrated the *quasi*-rigidity that rapid rotation gives to a flexible or fluid body. A thin sheet of paper assumed the stiffness of a board. A chain released from a hub rolled like a solid wheel. A fly-wheel being made to revolve rapidly when inclosed in a brass box, the box did not tumble down, but maintained a vertical position and offered resistance to any attempt to turn it round. If it was tilted, it turned with a precessional motion. Every spinning body, the lecturer said, resists a change of direction of its spinning axis. Rotating machines on board ship offer greater resistance to pitching and rolling. A top thrown up would fall down anyhow; but if it was thrown up spinning, there would be no doubt as to the position it would come down in, because the spinning axis always keeps parallel with itself. The fall of a biscuit or a hat is equally controlled by throwing either with a spinning motion. For this reason the barrels of guns are rifled; and the same principle explains the feats of jugglers with hats, hoops, plates, umbrellas, and knives. All that appears incomprehensible in the curious motions of the gyrostat under various conditions loses its mystery when the motions are regarded as rotation about various axes; and herein is found the key to the phenomenon of precession. The application of these principles to the motion of the earth was illustrated by diagrams and by the wabbling motion communicated by the hand to objects with three axes, which, spun first on the shortest axis, would of themselves rise to spin on the longest axis. A circular chain hanging vertically from a cord, when made to revolve rapidly, first wabbled and at last became a horizontal ring. In dealing with the question whether the earth is a shell filled with fluid, the professor gave a vibratory motion to vessels containing respectively sand, treacle, oil, and water. A boiled egg had a slower oscillation than an unboiled one. When the two eggs were rolled, the unboiled one stopped sooner than the boiled one. The liquid inside went on moving and renewed the motion of the shell after it had been stopped by the finger. It is easy to spin a boiled egg, but not an unboiled one.

Sheep-raising in Algeria. — Sheep-raising is the principal business of the Algerian Arabs of the high plateaus. Neither the sheep nor the wool are of the first quality, but the sheep can resist a great variety of hardships to which they are subjected in the not very pleasant region they live in. As they require to be watered every two or three days in summer, they can not be taken for pasturage to regions far removed from a supply. They are not at all particular about the quality of what they drink, but water of some kind they must have; and no use can

be made of pasturage beyond a reasonable distance from springs. This area is therefore eaten down to the ground, while succulent pasturage beyond it goes to waste. Hardly more than one fifth of the extent of the high plateau, for this reason, is available. Algerian wool is Arab or Berber. Arab wool is generally of a short fiber, sometimes moderately, rarely very long, and regulated as to length by the climatic influences of the localities where the sheep are raised. It is always short on the high plateaus, and becomes longer as the sheep descend into more fertile and better watered regions; but in both instances it is pure wool, of a fine quality, and without any hairy appearance. Berber wool is hard and coarse, and is confined to mountainous and sometimes inaccessible regions, where there is constant pasturage, and the migration of flocks in the summer season is unnecessary.

Care of our Eyes.—Few persons are aware, says M. Félix Hément, that besides size, shape, and color, their eyes differ in visual force and in power of accommodation; and also that some faults affect only one of them. It is an established fact that we all use one eye—the right or the left—in preference, when looking through a glass or taking aim with a gun. We are right- or left-eyed as we are right- or left-handed or footed. If we do not perceive this ourselves, oculists and opticians remark it. The ignorance of most people on this subject is illustrated by their buying glasses at the opticians without taking account of any difference between the eyes. Thus only one of the eyes is helped, while the other one, being less called into exercise, becomes less and less useful, and loses its powers as a tool rusts when it is not in use. Yet both our eyes are needed to see well. It becomes, therefore, highly important to observe how the child uses its eyes, in order to correct those attitudes which tend to injury of the sight as well as of the health. Children, in writing, rarely fail to give the head an inclination by which the eyes are placed at unequal distances from the paper. They are also apt to incline their head too far, and acquire the habit of bringing it too near, as when they try to accommodate themselves to a feeble light. Not sufficient attention, we think, is given to these matters, especially when we consider the consequences of such habits in mature age. A large proportion of our defects originate in want of proper care during childhood. We do wrong to such wonderful tools as our senses when we do not give them the education they need. Is it not surprising that parents who are so particular about the way their children hold their fork or spoon pay so little attention to the way they use their eyes?

Stone Chips.—Describing to the American Association the aboriginal stone implements of the Potomac Valley, Washington, D. C., Mr. W. H. Holmes said that they were of soapstone, quartz, and quartzite. The Algonquin peoples quarried the soapstone to get stuff for vessel-making. The quartz and quartzite were made into spear-heads, arrow-points, and knives, and the material was obtained from bowlders dug from the bluffs. In shaping the implements, which was done by percussion, thousands of stones were thrown aside because of flaws. Leaf-shaped blades were made at the quarries and carried to the villages to be finished. When the village was at the quarry-site, relics of all the stages of progress were found in the refuse. Where the villages were not located on the quarry-sites, no rude forms were found, but only the blades and the fully finished tools made from them. Hence, the author contended, the rude forms of chipped stones are not tools at all; and the difference between the "rough stone age" and the "smooth stone age," insisted upon by French archæologists, disappears. Mr. Holmes was supported by Prof. Putnam, but Dr. O. L. Mason was not ready to see their theory so summarily disposed of.

Our Most Usual Words.—Prof. Jastrow communicated to the American Association a curious study of processes involved in every-day mental life. Twenty-five men and twenty-five women, students in a class in psychology, wrote as rapidly as possible the first hundred words that occurred to them. Of the five thousand words written only 2,024 words were different. Twelve hundred and sixteen words occur but once in the lists. Omitting these, about three thousand of the words were formed by the repetition of only

758 words. Passing to an analysis of this "mental community," it becomes clear that it is greatest at the beginning of the list; that is, the habit was shown to be to write first the most common words, and, when these are exhausted, the more unusual ones. The lists of words drawn up by women were much more like one another than those written by the men. The women used only 1,123 different words, the men 1,376; the women wrote only 520 words occurring but once in the lists, the men 746. The lists also indicate the relative prominence of different classes of ideas and objects in the minds of the writers. The five best represented classes are names of animals, articles of dress, proper names, actions, and implements and utensils. The women contributed most largely to the class of articles of dress, having given 224 words in it, while the men wrote only 129. They showed equal favoritism for articles of food, in which they wrote 179 words to 53 by the men. The men showed fondness for implements and utensils, names of animals, and abstract terms. Among the links by which one word seemed to suggest its successor were associations by sound and community of classification. In five hundred mentions of the twenty words most frequently recurring, the word preceding the given word was the same in 111 cases, and the word following it in 145 cases.

NOTES.

ACCORDING to the investigations of an Indian student of the Hindoo folk lore, published at Lucknow, it is believed that if a person is drowned, struck by lightning, bitten by a snake, or poisoned, or loses his life by any accident or by suicide, he goes instantly to hell. If he dies naturally on a bed or a roof, he becomes a *bhut*, or evil spirit; and with this belief care is taken on the approach of death to move the person carefully on to the floor. The earth is believed to be resting on the horns of a cow and the raised trunks of eight elephants, called *diggai*, or "elephants supporting the regions," and each of the cardinal and subcardinal points of the compass has its appropriate guardian. An eclipse is supposed to be produced by the occasional swallowing up of the sun or moon by the severed head of Rihu, son of a demon family, who was decapitated by Vishnu for disguising himself as a god and drinking nectar.

THE new system of railway fares introduced in Austria and Hungary, as has been shown by Prof. E. J. James, gives the Austrian Empire the cheapest railway fares in the world. Under it the usual fare for third-class passengers is about six and a half mills a mile, or $6.50 for a thousand-mile trip. Commutation rates for local service are still lower. Thus workmen can travel to and from work on the railroad for two cents a trip, up to six miles; four cents up to twelve miles; six cents up to eighteen miles; eight cents up to twenty-four miles; and ten cents up to thirty miles. Yearly tickets good for thirty-mile trips are sold for $17.40. These rates have proved profitable to the railways, and under them the traffic has increased so rapidly that the accommodations are taxed to the uttermost. The system is commended to the attention of American railway managers.

THE bush country of the South Island, New Zealand, is troubled by a periodical visitation of rats (*Mus maorium*), which appear in the spring every four years. They are considerably different in size and general appearance from the common brown rat, being less fierce in appearance, and weighing, in full-grown specimens, only about two ounces. They are slow and awkward in movement on the ground, but quite at home and extremely active in climbing trees. These they ascend with the nimbleness of flies, running out with amazing quickness to the very tips of the branches. Hence, when pursued, they invariably make for trees if any are in reach, or, if not, for anything that will take them from the ground—as when a rat, disturbed by a plow, ran up the horse-reins which were dragging on the ground. They betray themselves, when startled, by their cry—an indiscretion of which the common rat is rarely guilty.

ATTENTION is called by L. W. Wiggles worth to the use of a squirrel's tail as a steering and balancing organ during its leaps through the air. A squirrel was observed by a friend of the author's, in leaping from the height of thirty-three feet to the ground, to cause itself, by curving its tail strongly to one side just before alighting, to swerve in its course, and so avoid some hard substance on which it would otherwise have fallen.

EXPERIMENTS are being made in European navies with captive balloons as points of observation. From one sent up from a French ironclad, ships and the details of the neighboring coast could be seen, in clear weather, for twenty or twenty-five miles. With silk as the material of the cable by which it is held, the balloon could rise in calm weather to a height of four hundred yards. The subject has attracted the attention of the naval authorities in Germany and England.

Mr. C. B. Atwell says, in the American Microscopical Journal, that amœbas for laboratory purposes are obtained at the Northwestern University from the algæ of Lake Michigan. A quantity of the common alga (*Cladophora canaliculatis*) is put into a tumbler of water and allowed to stand for six or eight days, when a white film or ooze appears upon it which teems with amœbas and other protozoa. It is sometimes possible, in the rich supply thus obtained, to observe six, eight, or ten amœbas in the field at once.

Most people are probably not aware that there is one at least of the well-known stars compared to which the sun is a mere pygmy. Sirius, the dog-star, which is also a sun, is believed to have nearly five thousand times the volume of our sun. Its immense distance, probably a hundred million millions of miles, makes such measurement as is applied to the planets impossible. Hence the above estimate is based on a comparison of the light of Sirius with that received from the sun. It is the most brilliant star in the heavens, being far brighter than the first magnitude, and its light has a greenish tinge. During the winter months the place to look for Sirius is in the southern heavens.

OBITUARY NOTES.

Prof. Alexander Winchell, of the University of Michigan, died at Ann Arbor, February 19th, in the sixty-first year of his age. He was born in North East, Dutchess County, N. Y.; was graduated from Wesleyan University in 1847, and taught natural science in several academies till 1854, when he became Professor of Physics and Civil Engineering in the University of Michigan. In the next year he was transferred to the chair of Geology, Zoölogy, and Botany in the same institution. He was made Director of the Geological Survey of Michigan in 1859, and again, when the work was resumed after the interruption by the war in 1869, but resigned from the position in 1871. He was made Chancellor of Syracuse University in 1873, but gave up the office in the next year to be Professor of Geology, Zoölogy, and Botany there. In 1879 he returned to the professorship in the University of Michigan. Without giving up his regular duties, he also served as Professor or Lecturer of Geology, etc., in the University of Kentucky from 1866 to 1869, and in Vanderbilt University from 1875 till 1879. His office in the latter institution was abolished when he was found to be an advocate of the doctrines of evolution and of pre-adamites. He lectured much, and wrote numerous papers on geology. Fourteen new fossil species were named after him. He established the Marshall Group in American geology. The list of his books and papers includes about two hundred titles. His most important scientific works were Sketches of Creation, 1870; a Geological Chart, 1870; Michigan, 1873; The Doctrine of Evolution, 1874; Reconciliation of Science and Religion, 1877; Pre-adamites, or a Demonstration of the Existence of Man before Adam, 1880; Sparks from a Geologist's Hammer, 1881; World Life, or Comparative Geology, 1883; Geological Excursions, or the Rudiments of Geology for Young Learners, 1884; Geological Studies, or Elements of Geology, 1886; and Walks and Talks in the Geological Field, 1886.

Prof. Felipe Poey y Aloy, the distinguished Cuban naturalist, died in Havana, January 28th, aged ninety-one years. For more than sixty years he had contributed papers on natural history to the French, Spanish, and Cuban scientific press, to the Academy of Natural Sciences of Philadelphia, the Annals of the New York Lyceum, and to other American scientific publications. His chief work was his Cuban Ichthyology, in twelve folio volumes, containing descriptions of about a thousand species of fish, many of them noticed for the first time. His papers are said by Prof. Jordan to be the most valuable contributions yet made to our knowledge of the fishes of the West Indies. Other works are a Geography of Cuba, which reached nineteen editions; a general geography, and an elementary work on mineralogy. A sketch of his life and an account of his works, by Prof. D. S. Jordan, who knew him well, and a portrait, were published in The Popular Science Monthly for August, 1884.

Gottlieb Studer, one of the founders of the Swiss Alpine Club and its honorary president, died at Berne on the 14th of December, in his eighty-seventh year. He was a zealous mountaineer before Alpine clubs existed, was famous for his exhaustive topographical knowledge of Switzerland, was a draughtsman as well as a writer, and was the author of a Panorama von Bern and of Ueber Eis und Schnee, in four volumes.

Dr. José Jeronimo Friano, who died in Paris last fall, had made, before visiting Europe in 1860, a valuable collection of five thousand species of plants of New Granada. His chief object in visiting Europe was to determine his plants and prepare a Flora of New Granada, and this he began publishing, with the late Prof. J. E. Planchon, as a Prodromus Floræ Novæ Gratensis. Being insufficiently provided with funds, he became engaged in consular and medical work, and his Flora was suspended. He also published a monograph on the Melastomaceæ, and studies on the Quinquinas.

Mr. Lant Carpenter, eldest son of the late Dr. William B. Carpenter, and himself a lecturer on scientific subjects, died about the 1st of January.